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METHODS OF SUBAQUEOUS ROCK EXCAVATION, BUFFALO HARBOR, N. Y.

At the present time the United States Government is actively engaged at Buffalo, N. Y., in the formation of a channel 2,300 ft. long, 400 ft. wide and 23 ft. deep at mean lake level, and a branch channel and basin, 1,920 ft. long, 500 ft. wide and also 23 ft. deep at mean lake level.

This improvement is known as the Lake Erie Entrance to Black Rock Harbor and Erie Basin, N. Y., and was authorized by the river and harbor act of June 13, 1902, which carried an appropriation of $814,643 for the work.

Appendix Q Q of the Annual Report of the Chief of Engineers, U. S. Army, being the report of the district officers, Theo. A. Bingham, Major, Corps of Engineers (now Brig., U. S. A., retired) and P. S. Bond, First Lieut. Corps of Engineers, U. S. A., which has just been published, contains more or less information relative this work, and has been drawn upon in the preparation of this article, but the greater portion of the matter herein given has been secured from other sources.

The plans and specifications for the improvement, were drawn up under the direction of Major T. W. Symons, Corps of Engineers, U. S. Army.

The area embraced within the channel is about 30½ acres and within the channel is about 22 acres.

The estimated amount of material to be excavated from the channel is 300,000 cu. yds., place measure, of which approximately 20%, or 61,000 cu. yds., is rock, and 80%, or 239,000, cu. yds. is earth, mud, clay, etc.

In the basin the total amount of material to be removed is 325,000 cu. yds. place measure, of which approximately 87½%, or 285,000, is rock, and 12½%, or 40,000, is earth, sand, clay, etc.

The specifications provided for a specified price per cubic yard for the channel work in place, and another specified price per cubic yard for the basin work in place, all without regard to classification of materials.

Bids for the execution of the work were opened Jan. 22, 1903. The proposal of the Buffalo Dredging Co., of Buffalo, N. Y., was found to be the lowest, and the work was let to them at the following prices:

Excavation of channel, per cu. yd. place measure, $0.66.

Excavation of basin, per cu. yd. place measure, $1.84.

The estimated cost at contract prices was $796,000.

The operation of rock drilling and blasting for the season of 1903, commenced July 14, 1903, and were terminated Nov. 7, 1903. The greatest number of drill boats engaged in the work at one time, was 5, but generally 4 were engaged.

The area drilled over during the season of 1903, comprised 285,000 sq. ft.

The average depth of rock above the required grade of 23 ft. below mean lake level was 2.44 ft., but in order to insure the required depth after blasting and dredging, the holes were put down to 25 ft. below mean lake level.

PLANT.—The necessary plant for this class of work usually consists of a suitable hull, either of wood or steel, on which a house of proper dimensions is erected and in which are contained the boiler, pump, dynamos, forge, coal bunkers and other paraphernalia incident to the plant, all of which are arranged along one side of the house. Ranged along the opposite side of the hull are the frames carrying the drills and telescopic pistons worked by hydraulic pressure for raising and lowering the drills, which latter are operated by steam power.

On the earlier drill boats generally but two drills were employed, which were afterwards increased to three. Now four drills are commonly used, the hulls being proportionally larger.

Figs. 2, 3 and 4 illustrate a modern type of drill boat, with a hull built of steel.

The hull is 106 ft. long, 30 ft. wide and 6 ft. deep.

On this hull a wooden house is erected, this house measures 86 ft. long and 18 ft. wide, with a sloping roof 12 ft. high on the drill side and 11 ft. on the opposite side.

There are 4 drill frames, each carrying a Rand machine drill, attached to telescopic pistons, by means of which the drills are raised and lowered. The pistons are worked by water pressure, a pump being used. The drills being operated by steam pressure, from a boiler that is 12 ft. long and 7 ft. diameter.

The drill frames rest on rails laid on the deck of the hull, and are moved back and forth by a rack and pinion.

The different pipes, supplying water and steam to the pistons and drills, respectively, have their joints so arranged as to provide great flexibility, by which they accommodate themselves readily to every change of vertical and horizontal movement.

A supply of drill rods is constantly carried in the drill boat, the X-bits of which are kept in proper order by a blacksmith and two helpers. They are supplied with a forge, supplemented by a hydraulic hammer.

The drill boats are usually operated day and night, and in two 11-hour shifts.

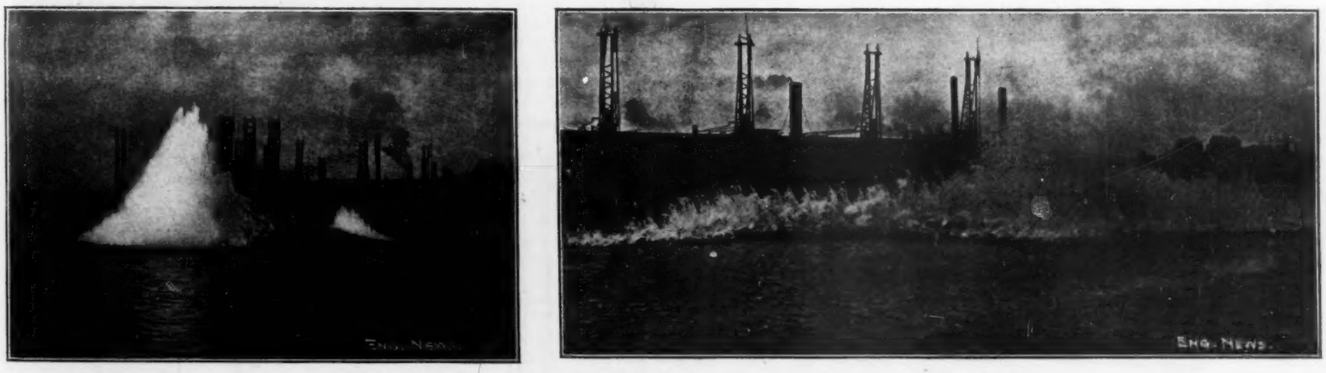
OPERATING DRILL BOATS.—In operating the drill boats the boats are first towed to an approximate position by a tug boat, and accurately alined by means of properly set targets on the shore. They are held in place by the anchor spuds, of which there are four, one in each corner. These are all worked by hydraulic pressure.

In shallow drilling the spacing of the drill holes was generally 4 × 5 ft., equivalent to 0.74 cu. yds. place measurement per lin. ft. of drill hole.

A drilled hole was usually shot soon after its completion to the proper grade, the comparative shallow depth of the hole, about 5 ft., and the great depth of water above the same, 20 ft., making the removal of the drill boat unnecessary.

On the completion of a series of holes, about 20, the drill boat was moved onto the next range.

Two months' time was occupied in the dredging



SUBMARINE BLASTING FOR ROCK EXCAVATION IN BUFFALO HARBOR.
(A charge of 400 lbs. of dynamite placed in holes drilled in the bottom at a depth of about 20 ft.)

and disposition of the drilled and blasted material, which amounted to 37,570 cu. yds., scow measure, or 18,785 cu. yds., estimated place measure, as stated in Appendix Q Q, of the Annual Report of the Chief of Engineers, U. S. Army for 1904.

In this connection it is interesting to show the enormous capacity of the dredge which dredged this rock excavation.

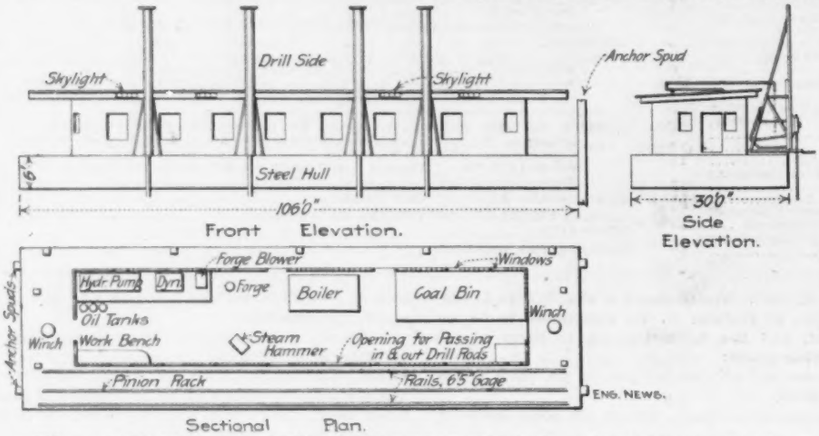


FIG. 1. PLAN AND ELEVATIONS OF DRILL BOAT FOR USE IN SUB-AQUEOUS ROCK EXCAVATION, BUFFALO, N. Y.

During the dredging operations a slab of lime stone was caught lengthwise in the dipper, measuring 3 ft. high, 7 ft. wide and 15 ft. long, weighing 26½ tons, Figs. 5 and 6.

The effect of blasts on the surface of the water is shown in the photographs reproduced on the preceding page. In each case 24 holes containing 400 lbs. of 75% dynamite were fired.

ANNUAL CONVENTION OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS AT ASHEVILLE, N. C.

(Concluded from p. 691, June 29, 1905.)

THREE-PHASE TRACTION.

In two extended papers, advocates of the three-phase induction motor once more put forward this machine for electric railway use, as they have done on repeated occasions in the past. However, if the discussion at the present convention can be taken as index, the sentiment of electrical engineers in this country is turning away farther than ever from three-phase traction. The papers in question are

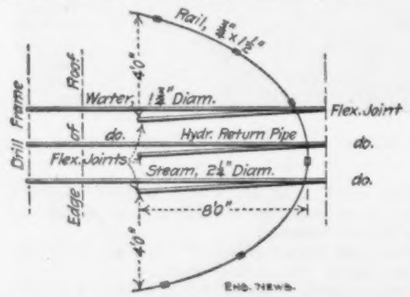


Fig. 2. Plan of Pipes on Roof Showing Flexibility to Allow Moving Drill.

"Three-phase Traction," by Mr. F. N. Waterman, (New York, N. Y.), and "Heavy Traction Problems in Electrical Engineering," by Mr. C. L. De Muralt (New York, N. Y.) Mr. Waterman presented a study of three-phase operation on the Valtellina Ry., in northern Italy, giving figures as to energy required, energy returned in coasting and braking, speed-time curves, station-load curves, etc., and applying these to various schedules. The two types of locomotive used on the Valtellina line, with two-speed and four-speed control, respectively, are separately considered, the latter but briefly as it has been in use only a short time. The author concludes:

> Whatever may be the future of three-phase traction, the conclusion seems clearly warranted that were there no other system, all traction business that permits a private right-of-way could be handled as well and as economically as at present, and that it could be done with a smaller average cost of installation and at a cost of operation which would often be materially lower than present attainments. There is also good reason to believe that maintenance charges would not exceed those now submitted to and that while such charges would undoubtedly be differently distributed they would not involve any reduction of equipment mileage. Eighteen years of experience have brought the direct-current system to a high state of development, while with only one case of serious working out on a large scale, the three-phase system is showing results which, from the standpoint of effectiveness and economy, seem not inferior. The evidence of flexibility already observed gives reasonable promise that others may be expected, and it will be indeed strange if some field of utility is not found wherein pre-eminence is attained.

and later, speaking of the four-speed motors,

> Therefore the small air-gap motors at 25 cycles and with four-speed control show a great superiority in performance over direct-current motors. On the same basis of weight, friction and schedule, and a much lower average acceleration, these motors take 81% of the power required by the direct current (at the switchboard); they have 47% of the average losses in transmission and cost 76.5% for the entire equipment, or 56% for generating and distributing equipment.

It should be noted that the two-speed motors above referred to operate at 14 cycles per second, while the four-speed motors operate at the frequency of 25, which is so widely used in America.

Mr. de Muralt gave a comparative estimate of cost of installation and operation of electric equipment on a railway having a 175-mile main line and a 49-mile ore road, both starting from a common terminus. Direct current third rail at 1,000 volts, with high-tension distribution and three-phase alternating current at 5,000 volts trolley pressure were compared. The cost of installation is computed as $2,792,552 and $1,867,716, respectively, for the two cases. The power consumption is found to be about the same in both cases, but the avoidance of substation attendance and some other items in the three-phase system are said to make the operating cost lower.

As the papers bring out no new device or method, but merely argue in favor of a system already known, we give only brief reference to the discussions. Numerous objections were raised against the views and statements of the authors, and practically no support was given to the three-phase system. Messrs. W. N. Smith (New York, N. Y.), C. P. Steinmetz (Schenectady, N. Y.); C. O. Mailloux (New York, N. Y.), H. G. Stott (New York, N. Y.), and Wm. Stanley (Great Barrington, Mass.) made remarks in opposition to the three-phase system for traction work. Three points out of the many advanced in the discussion may be noted. The return of energy by three-phase motors in running down hill must be done at half-speed as running beyond synchronous speed down grade would probably be excessively dangerous; but at half speed the efficiency of the motors as generators is low, which means great heating of the motors, and hence larger motors for the same service. The return of energy which would take place on small systems when load is thrown on, by the generators slowing a trifle (3 or 4%, enough to leave the loaded motors running momentarily above the new synchronous speed) and therefore the trains feeding back into the line, would not occur on systems of any size; the station-load curve, therefore, is, if anything, more irregular than in the ordinary system, especially as the return of energy by several trains simultaneously going down grade may drop the load curve below zero. Since the cost of power in large systems is about in inverse ratio to the load factor (H. G. Stott), the three-phase system is at a disadvantage where the author sees an advantage, i.e., in the pretended better load-factor. A wholly different and quite serious matter, where three-phase motors have a slip of only 2 to 3% at full load, is that when one pair of wheels is only 1% smaller than the other, the motor will carry 50% more load than the other; this holds good for all axles in a motor car train, as well as for the axles of a single unit. It was mainly this difficulty that led to the use of coupled axles on the Valtellina locomotives; multiple unit operation, where coupling rods are out of the question, made necessary the insertion of a variable secondary resistance, whereby the effective slip of each motor could be varied, at intervals, to suit the diameter of its wheels.

Two papers on electric traction, apart from the question of kind of system, were presented. These are "Choice of Motors in Steam and Electric Traction," by Mr. Wm. McClellan (Philadelphia, Pa.), and "Weight Distribution of Electric Locomotives as Affected by Motor Suspension and Drawbar Pull," by Mr. S. T. Dodd (Schenectady, N. Y.). The former presents, first some figures on elements of steam locomotives, showing the great variations existing in practice in such items as per cent. of weight on drivers, size of drivers, engine weight per unit drawbar pull, ratio of heating to grate surface, etc. The author remarks that this diversity implies that the steam locomotive is still in a continued state of development, by trial, with little tendency toward desirable standardization. He proceeds to point out the many variations in commercial electric railway motors, of which about 100 kinds may be bought in this country. The variations affect winding of armature and field, voltage, speed, gear-ratio, etc. This diversity

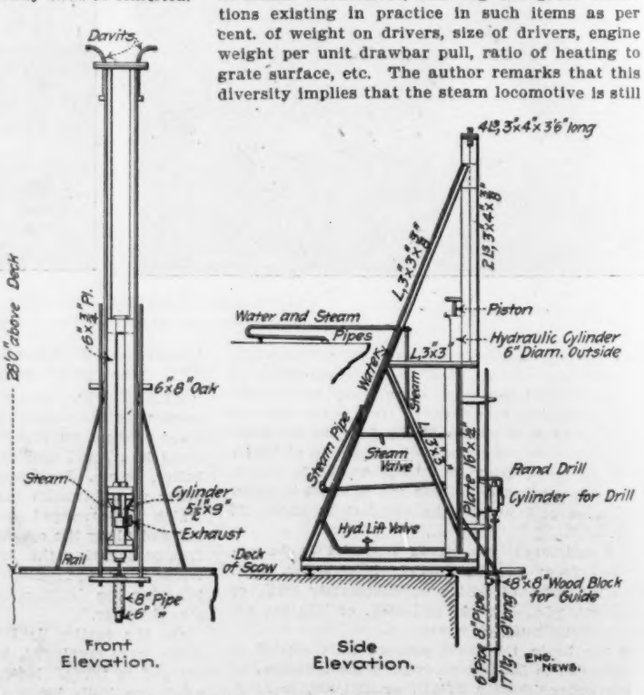


FIG. 3. FRONT AND SIDE ELEVATION OF DRILL AND FRAME.

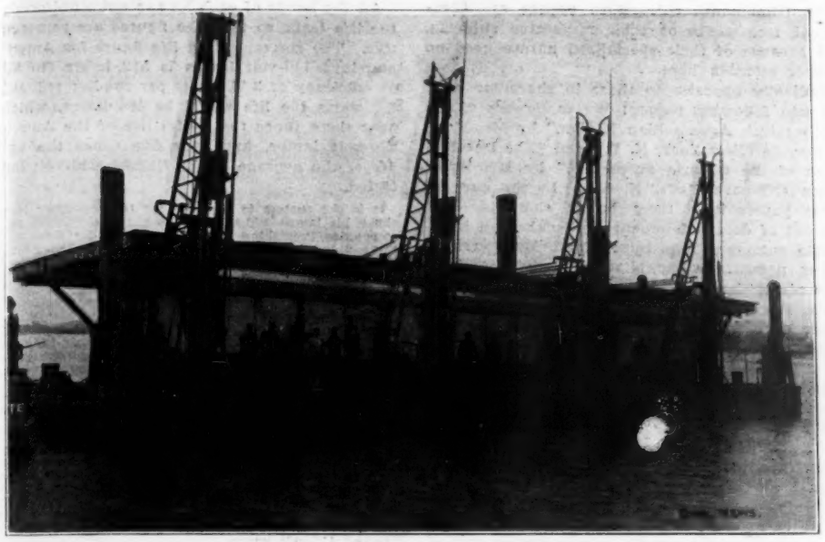


FIG. 4. DRILL BOAT NO. 1, WITH FOUR DRILLS.

exists in spite of the fact that railway motor development and manufacture has been and is practically in the hands of but two corporations, whereas locomotives have always been built by a great number of makers and to suit the special ideas of a great number of railway officials. There is, he continues, little reason for such great diversity in electric motors particularly since actual operation is always quite different from the most careful predeterminations as to type of run-curve etc. He cites gear-ratio as an instance of needless variation, there being no practical difference between ratios of 3.24 and 3.28. In conclusion he urges that standardization of railway motors would be very advantageous in its effect upon the extension of electric railroading.

There was no assent to this suggestion in the discussion. In the matter of gear-ratio, as an instance, Mr. Steinmetz stated that the approximate ratio being first fixed, a pinion is put in as large as possible, to give the maximum wearing area, and at the same time the numbers of teeth in gear and pinion must be prime to each other, so as to distribute the wear evenly. This always results in odd gear ratios, and usually gives different ratios for two different but closely similar cases. An instructive object lesson in the matter of standardization was cited by Mr. H. G. Stott (New York, N. Y.). The 5,000-KW. engines for the Manhattan Ry. power house in New York had barely been all-installed when the same type of engine was ordered from the same maker for the Interborough Subway power house. The design and building of these latter was, therefore, practically continuous with that of the first lot. Yet the Subway engines when erected, were found to differ from the earlier ones in nearly every detail, not only in valves and gear, but even in such matters as cranks, pins, etc. This is the case although modern steam engine building has been in progress for over half a century.

The paper of Mr. Dodd discusses a subject of more general interest and value than the preceding, but of a nature making abstract or summary impossible. The author considers the effect of drawbar pull in changing the distribution of wheel loads: thus, in a two-axle locomotive, the rear wheels bear increased load, while the front axles have their loads decreased, by amounts easily computed. In locomotives of more complex framing, however, the redistribution is more complicated; equalizers, method of motor suspension, and location of motors are factors in the problem. Quite a number of cases is summarized in the paper, formulas being given in each case for the resulting wheel-loads. The matter is of much importance in electric locomotives, as the traction per motor must never exceed the adhesive power of the most lightly loaded pair of drivers, or the wheels will slip. The tractive power of the locomotive is therefore reduced by the full percentage by which the load is decreased on the worst axle. The effect may be as high as 20% in some locomotives. Mr. F. N. Waterman (New York, N. Y.) stated in discussion that the effect analyzed by the author was observed on the Manhattan (Elevated) Ry. some years ago, and some trouble was experienced in guarding against wheel-slipping from this cause.

A paper closely related to electric traction was presented by Mr. L. H. Thullen (New York, N. Y.) under the title "Electric Features of Block Signalling." After introductory mention of signal systems used on steam railways, the paper describes the general type of signal system used on some recent electric rapid transit roads, the Boston Elevated, the North Shore route, the New York Subway, etc. The latest system, of the type used on the latter line, uses the track rails for both the power return and the signal circuit. The signalling current is alternating, and inductive rail bonds are placed between the track sections to confine the signalling current, while giving free passage to the power return (direct current), as in the Young system described in Engineering News of Dec. 24, 1903. To guard against difference in resistance between opposite rails of a section, the inductive bonds are so proportioned as to permit a large unbalanced current to flow across the bond without reducing its impedance to the alternating current, i.e., without approaching saturation.

DIRECT-CURRENT MACHINES.

The problem of direct-current machinery was discussed by Mr. Thorburn Reid (New York, N. Y.), in a paper "Limits of Injurious Sparking in Direct-Current Commutation," and by Mr. Sebastian Senstius (Cincinnati, O.) in a paper on "Limitations in Direct-Current Machine Design."

Mr. Reid's paper is a mathematical argument in support of a hypothesis which he advanced in 1898, in explanation of sparking at the commutator surface and cutting of the commutator. This hypothesis is that the injury done by sparking at the brushes of a direct-current dynamo is not due (as commonly supposed) to the current jumping across the gap between the segment and the brush, but is done while the brush is in contact with the segment, the copper of the segment being first melted and then volatilized by the concentration of current energy at one or the other of the segment edges. The author makes out a plausible case for his theory, but there is nothing in the way of experimental proof to support any part of his conclusions. That a part of the commutator surface, while under the brush is raised to a temperature of 2,000° F., even though it be but a very small area and in an exceedingly thin layer, and that this piece of surface should then fall to normal temperature by the time the next brush is reached, is sufficiently improbable on its face to require good experimental support before it can be accepted.

Mr. Gano S. Dunn (Ampere, N. J.) stated his belief that volatilization of some kind is proved by the deposition of a copper film on the under side of one brush, without sparking; this film, which always appears on the brush from which

FIG. 5. 26½-TON STONE LIFTED BY DREDGE.

FIG. 6. DIPPER AND 26½-TON STONE.

the current emerges, may be transferred to the other brush by reversing the excitation. But he does not believe that a heating action is the cause of this deposit, because he has run solid brass and copper rings at enormous current densities without ever getting a trace of such deposit. The cutting and transverse striation which appears on badly running commutators may generally be cured by using a new form of brush, invented by F. W. Young, in which a dead brush trails a very small distance behind the live brush, causing the current just at commutation to pass through three contact surfaces instead of one. Mr. C. P. Steinmetz (Schenectady, N. Y.) remarked that it has lately come to be accepted that the phenomena under the brush, rather than sparking, are responsible for bad commutation. But the author's calculation is in error if in no other item, in assuming a constant unit resistance of the contact surface, whereas this unit resistance varies with brush pressure, speed and current density.

The paper of Mr. Senstius presents, in semi-mathematical form, the main considerations that limit the design of direct-current machines. The center of the difficulties is, of course, the capability of the brush. The author uses certain figures, based on test or experience, for the sparking-pressure and the maximum current-density for various commercial brushes. The conclusions derived from these figures, in connection with developments of the electrical formulas applicable to direct-current machines he employs to calculate the maximum practicable sizes of direct-current generators which can be built for respective pressures of 125, 300, and 600 volts, at an engine speed of 75 r. p. m. The computed output sizes are 1,175, 1,800 and 1,450 k.w., respectively, and the corresponding armature diameters are 230, 240 and 180 ins. As Mr. G. S. Dunn pointed out the author's work is in line with a general principle set up in 1892 by Parshall, that the current per pole is limited. The speaker agreed with the author's method, but not with his figures, considering the 125-volt size too great and the 600-volt size too small to suit the facts. The same stand was taken by Mr. W. L. Waters (Milwaukee, Wis.), who referred to a 2,700-k.w. machine running at Boston, and by Mr. C. P. Steinmetz (Schenectady, N. Y.), who referred to several 5,000-k.w. commutating machines 250-volt running in Boston. Many criticisms in detail were made of the assumptions on which the paper is based, all tending to the view that the concrete figures deduced by the author cannot be taken to be generally true.

Related to the subject of the direct-current machine *per se* is the subject of converters, which Mr. W. L. Waters discussed in a paper entitled "Synchronous Converters and Motor Generators." The comparison is between rotary converters on the one hand, and motor-generator sets in which the alternating-current motor is of the synchronous type, on the other hand, for the conversion of alternating to direct current. The author assumes that modern practice does not use induction motors in motor-generator sets exceeding 100 KW. in capacity. The converter requires transformers to reduce the alternating current to the proper voltage, while the motor-generator set does not; yet the efficiency of the latter is in all large sizes lower than that of the converter and transformer combination. The latter, however, generally occupies more floor-space and costs slightly more. These factors and numerous operating conditions are discussed, with the conclusion that

> Broadly speaking the tendency to-day is toward motor-generator sets in lighting systems and synchronous converters on traction systems.

The discussion of the paper showed different opinions, more or less definite, in favor of one or the other type of apparatus. But the points elicited call for no detailed mention here, as the cases for and against the two types appear to be fairly even.

Two papers of detailed nature, having interest almost exclusively to the designer, were "A Study in the Design of Induction Motors," by Prof. C. A. Adams (Cambridge, Mass.), and "Eddy Currents in Large Slot-Wound Conductors," by A. B. Field (Cincinnati, O.). Both papers are theoretical treatments of their respective subjects, and because of their specialized nature need no further mention here.

Radically opposite to these in character were the two following papers: Water Powers of the Southeastern Appalachian Region," by Mr. F. A. C. Perrine (New York, N. Y.), and "The Development of the Ontario Power Co," by Mr. P. N. Nunn (Niagara Falls, N. Y.). In the case of these papers it is their broad character and amount of detail statement that makes an intelligible summary here impossible. Mr. Perrine's paper presents a compilation of hydrographic data about the rivers lying in the States of Virginia, the Carolinas, Georgia and Alabama. The paper on the Ontario Power Co.'s 200,000-H.P. plant on the Canadian side of Niagara Falls gives quite a detailed description of the location and conditions of the plant and its arrangement and construction. The plant is of the penstock type, has horizontal shaft turbines in units of 12,000 H.P., and is of special electrical interest in the great care taken to secure thorough separation of each unit throughout the plant from penstock to feeder-cable. The cables are nowhere concentrated at one point or in a single space where an accident might put the whole system out of service.

INCANDESCENT LAMPS.

Much interest lies in two papers on incandescent lamps, presented by Mr. John W. Howell, (Harrison, N. J.). They are entitled, "Some comments on remarks made by Col. R. E. B. Crompton before the International Electrical Congress at St. Louis," and "A New Carbon Filament."

The latter paper is of particular importance for two reasons: first, it describes what appears to be a new form of carbon produced by special heat treatment of the ordinary carbon filament in the process of manufacture; second it announces that incandescent lamps of a commercial efficiency of 2.5 watts per candle can now be made, and that even higher efficiency seems to be in prospect. A full abstract of this paper will be given in another issue of Engineering News.

The other of the two papers mentioned gives the results of tests made on standard English incandescent lamps bought in the open market without selection, of five different makes chosen as the best English makes, and comparative figures for standard American lamps as generally sold. The starting point of the inquiry was a categorical statement made at the St. Louis Congress by Col. Crompton to the effect that 220-volt lighting had, in England, been found to be more efficient and satisfactory to consumer as well as central station. Since in America it has been found that the 110-volt lamp is sufficiently better in efficiency and length of life to make 220-volt lighting disadvantageous, it seemed that a large difference must exist between American and English incandescent lamps. The tests were made to determine the difference. Test results on candle-power, watt consumption, and length of life, under standard test conditions, are presented in full in the paper. The results are very striking and are excellently summarized in the following.

English lamps.	Candles.	Watts per candle.
Make C (25)	15.5	4.00
D (25)	13.5	4.65
B (25)	14.3	4.53
A (25)	14.5	4.37
E (25)	11.4	5.2
American lamps. (about 50)	16.2	3.83

All these lamps were labelled 220 volts 16 c.p. The figures must be supplemented by the remark that the English lamps show a very great lack of uniformity in the individual lamps (25 in number) of each make. The results as to life, all lamps being burned at the rate of 3.1 watts per candle were as follows, the number of hours being the time required to reduce the candle-power to 80% of the initial value:

English lamps.	Life, hours to 80%.
Make C (15)	104
B (15)	88
E (15)	65
D (15)	82
A (15)	72
American lamps. Edison (15)	156

All the lamps of each lot ran quite uniformly in the life tests, so that the figures are representative. The corresponding life figure for American standard 110-volt lamps is 512 hours (to 80%), at efficiency of 3.14 watts per candle; reduced to 3.1 watts the life would be 480 hours, which is over three times the useful life of the American 220-volt lamps, and over five times the useful life of the average of the English 220-volt lamps tested.

It is the custom in England for the consumer to purchase his lamps where he pleases, the electricity supply companies furnishing current only. Under these conditions using lamps of the same efficiency and considering them dead when they have fallen to 80% candle power, the customer using 220-volt lamps would have to buy three times as many lamps as one using 110-volt lamps and each lamp would cost more money. Or, if lamps of equal life were used, each 220-volt, 16-candle lamp would consume 11 watts more than a 110-volt, 16-candle lamp. Assuming that both lamps last 500 hours, each 220-volt, 16-candle lamp would consume 5,500 watt hours or 5.5 kw-hr. more than each 110-volt lamp; and with current costing 10 cents per kw-hr. each 220-volt lamp of 16-candle power would during its life consume 55 cents' worth of current more than each 110-volt lamp.

These tests indicate a general lack of information on the part of the English consumers on the subject of quality and performance of lamps. It is not surprising that people who will continue to use lamps so poorly rated for volts and candle power as these are, would not appreciate the difference between 220-volt and 110-volt lamps. But the English engineers should know the difference between good and bad lamps and between 220 and 110-volt lamps.

ELECTRICAL INSTRUMENTS.

Two new measuring instruments were described in papers before the convention. Mr. E. F. Northrup presented "A New Instrument for the Measurement of Alternating Currents." The instrument is of the hot-wire type, but has two wires and a differential action, so that measurement may be made by balancing a known current against an unknown. The hot-wire principle and the fact that the construction of the instrument secures both a very great sensitiveness and a high insulation strength, promise it a large field of use. An abstract of the description will be given in another issue of Engineering News.

Prof. C. A. Perkins (Knoxville, Tenn.) presented a short paper on "A Simple Device for Finding the Slip of an Induction Motor." The chief merit of the device lies in its great simplicity, as numerous but less simple arrangements have been devised that accomplish the same object. The principle, as in most other methods, is stroboscopic. The current supplied to the motor in question is led through the coils of a small electro-magnet which has a loaded flat spring as an armature. This spring will then vibrate in absolute synchronism with the frequency of the supply current and its amplitude of motion may be adjusted by proper weighting of the spring. On the shaft of the induction motor is mounted a circular paper disk, which has as many holes distributed around the circumference as the motor has pairs of poles. By observing the spring through these holes while the motor rotates, the spring will appear to execute a vibration whose period is the slip periodicity. The number of vibrations may be counted very accurately, and when the supply frequency is known the percentage of slip is directly calculable.

TWO NEW FORMS OF GENERATOR.

A subject of great interest to the development of alternating-current machinery was opened up by a paper read by Mr. William Stanley (Great Barrington, Mass.), with the title "A New Induction Generator." The machine to which the paper more directly refers is an alternating-current generator very similar in construction to an induction motor. Both rotor and stator have distributed winding. A low-frequency current is supplied to one of the windings, and a current of frequency equal to the sum (or difference) of this and the rotation frequency is drawn from the other winding. By proper proportioning an almost ideal regulation is obtained, the armature reaction being almost wholly neutralized. The supplied exciting current may be either positive or negative, that is it may represent a supply or a draft of energy with respect to the alternator. In either case, however, it requires a low frequency rotating machine or exciter to determine its frequency and voltage. The design of a practicable low-frequency machine was the second problem in the work. Its solution was found in

a commutator machine with distributed windings on both rotor and stator in which an auxiliary set of angularly displaced brushes (or the setting of the main brushes in a three-phase machine) determines the self-exciting current going to the stator winding.

The paper presents, besides, the general explanation of the action of the two machines, a number of test curves showing the regulation obtained at various power-factors. The results and the machines are still strongly in the experimental stage, but the author

hopes to be able to convince (at a later time) the members of the Institute that machines excited by continuous currents cannot compete with those employing alternating-current excitation, as the latter possess distinct advantages in simplicity, performance, and cost.

There appears to be good ground for the ultimate realization, at least partial, of the sentiment expressed. The discussion of the paper brought forth from Mr. C. P. Steinmetz a lucid explanation of the main alternator described by Mr. Stanley, on the view that it is an induction frequency converter; the characteristics of regulation follow quite readily from this view. An important matter brought out by a query in the discussion is that the alternator, which may be run reversed as a motor under the proper conditions, seems to offer the possibility of securing a number of "synchronous" speeds, by changing the frequency of the exciter current.

A paper entitled "Notes on the Power-Factor of the Alternating-Current Arc" was presented by Prof. G. D. Shepardson (Minneapolis, Minn.). It presented a summary of results obtained in some thesis work at the University of Minnesota on the effect of current strength and wave-form upon the power-factor of an alternating-current arc lamp, both across the arc and across the lamp. The tests while not complete, indicate high and fairly constant power-factor (95 to 99%) across the arc when cored carbons are used, and lower power-factor (85 to 90%), decreasing with current, when hard carbons are used. The power-factor of the lamp depends in any case mainly on the coils. No material difference was observed in any of the tests between a sine wave, a peaked wave, and a flat-topped wave, in the effect on the power factor of either arc or lamp.

TREATED TIES AND CARE OF TIES ON THE ATCHISON, TOPEKA & SANTA FE RY.

The Atchison, Topeka & Santa Fe Ry. is noted for its extensive use of treated ties, and we have received from Mr. E. O. Faulkner, Manager of the Tie and Timber Department, some interesting diagrams as to the use and service of these ties. In the accompanying table we have given the figures from two diagrams showing the total number of treated ties laid in this country (exclusive of ties laid for test purpose) and the number of treated pine ties laid on the Atchison, Topeka & Santa Fe Ry. from 1885 to 1904, both inclusive. The accompanying diagram, Fig. 1, shows the percentage of treated ties removed from the division east of Albuquerque, N. M., from 1897 to 1904. In this diagram the dates on the curves represent the years in which the ties were laid, while the dates of the vertical divisions show when the ties were removed on account of decay. The horizontal divisions represent the percentages of these

Year.	Total No. of treated ties laid in U. S.	No. of treated pine ties laid by A. T. & S. F. Ry.
1885	111,503	111,503
1886	482,114	333,296
1887	458,907	189,386
1888	604,474	285,104
1889	578,670	169,174
1890	571,675	105,753
1891	648,661	128,568
1892	760,185	187,270
1893	762,993	178,167
1894	950,500	247,566
1895	1,281,331	256,887
1896	1,274,363	336,070
1897	1,751,277	365,696
1898	2,893,396	1,561,063
1899	4,335,956	1,826,368
1900	5,373,225	1,637,260
1901	4,564,682	1,563,572
1902	6,483,070	1,518,516
1903	10,282,066	1,820,850
1904	13,772,246	2,389,650
Total, 20 years	57,891,204	15,211,730

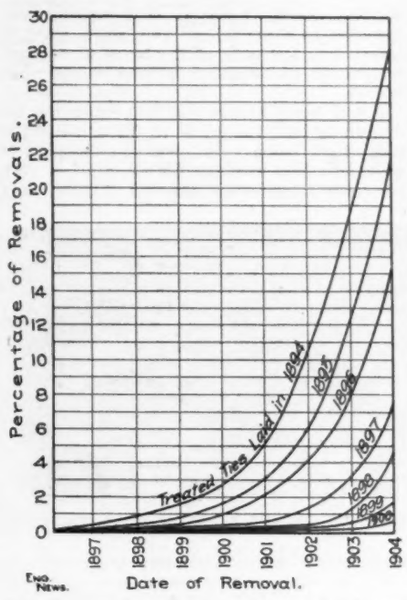


Fig. 1. Removals of Treated Ties on the Atchison, Topeka & Santa Fe Ry.: 1897-1904.

renewals. Thus it will be seen that at the end of 1904, 28% of the ties laid in 1894 had been removed after 10 years' service); 21½% of those laid in 1895 (9 years), and 15% of those laid in 1896 (8 years).

Mr. Faulkner also sends us a copy of a circular issued in May, 1905, showing the standard forms for piling ties, piles and poles in yards and on the right-of-way before and after treatment; the approved method of building the top row to shed water is also shown. In Fig. 2 is a reproduction of the sketches on the circular. No. 1 is a triangular pile; No. 2 is an open crib pile, with four ties in each course; No. 3 is a pile with alternate horizontal and inclined courses, separated by ties at the ends; No. 4 has horizontal courses separated by end ties; No. 5 is a crib pile with the outside ties of each course laid on edge; No. 6 is a solid crib pile; No. 7 is a similar pile for cypress ties only, with no inclined top course; No. 8 is a pile of telegraph poles or piles, with butts and tops reversed in each course; No. 9 shows the proper way to lay sawed ties or timber, with the annual rings all pointing downward. The instructions accompanying these sketches are as follows:

1. Ties must be piled in accordance with pile numbers best suited to local conditions.
2. Ground supports of sound stuff, giving not less than 6 ins. clear air space, must be used, and no rotten or decaying wood allowed to remain in any yard or near any pile. In piling ties not more than two for each pile should be in contact with the ground, excepting in triangular piles, as shown in No. 1.
3. Where roof courses are required, particular care should be taken in constructing them so as to obtain the desired protection, sufficient material necessary for this purpose being used.
4. In storage yards, each pile should be plainly marked with the month and year in which received, these marks to be placed where they can most easily be seen, and a clear space, preferably 4 ft,. left between each row of piles to facilitate seasoning.
5. Material must not be piled where any part is likely to come in contact with water, or where water can stand or run, on surface of ground, under the piles.
6. Tall weeds or high grass must not be allowed to remain near any material piled on the railway company's property.
7. Treated ties must not be placed in service until they have seasoned the full time described for that purpose.

TESTS OF THE EFFICIENCY OF VERTICAL STIRRUPS IN REINFORCED CONCRETE BEAMS.

The interesting and unsettled subject of shear in reinforced concrete beams gave occasion quite recently for some tests of reinforced beams at the yards of the Bush Terminal Co., Brooklyn, N. Y., preliminary to the final design of a large reinforced concrete building. The tests had the primary object of determining the behavior of beams provided with vertical stirrups in place of inclined metal, it being the opinion of the engineers that the former should be practically as efficient as the latter.

In order to exhibit the action of stirrups in a striking manner a reinforced beam was constructed in which bricks laid up dry took the place of concrete. Two 1-in. reinforcing rods ran along the bottom of the beam, the brick resting upon the rods. Stirrups of inverted U form, made of

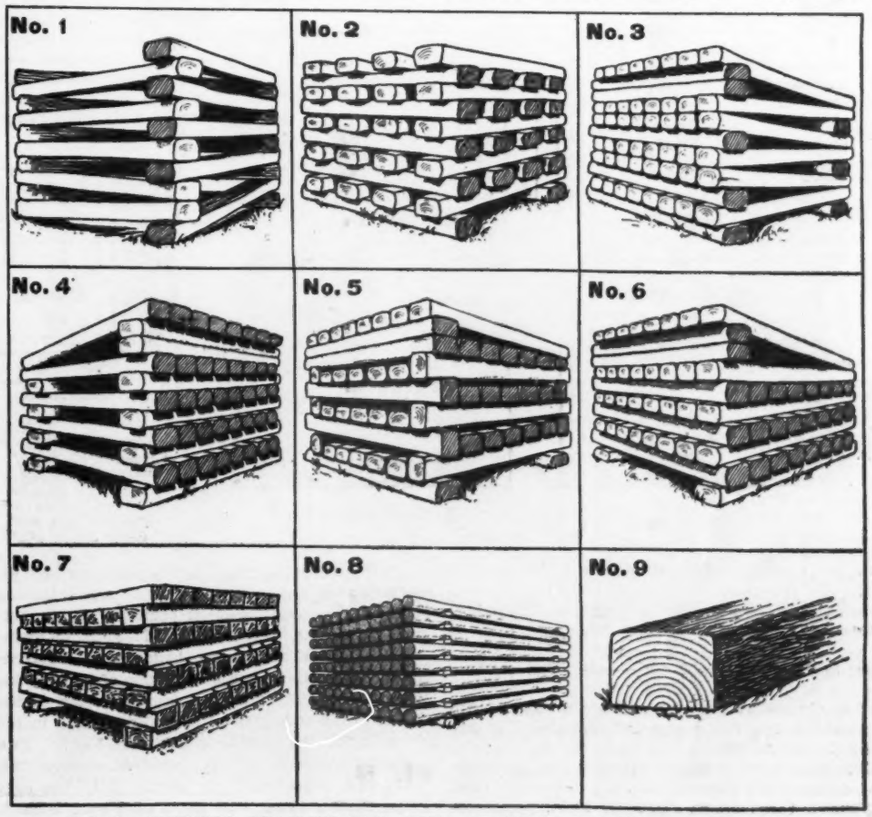


FIG. 2. METHODS OF PILING TIES, ETC.: ATCHISON, TOPEKA & SANTA FE RY.

5/16-in. rod, with the ends wound around the two rods, passed up between the vertical joints of the brick mass, and by their friction against the brick bound the mass together. The accompanying photograph (Fig. 1) shows the reinforcement metal without any brick in place. The two 1-in. rods were bent up 3 or 4 ins. at the ends, giving a length between bends of 13 ft. 7 ins. The stirrups (whose form is clearly apparent from the photograph) were about 8 ins. apart. Common

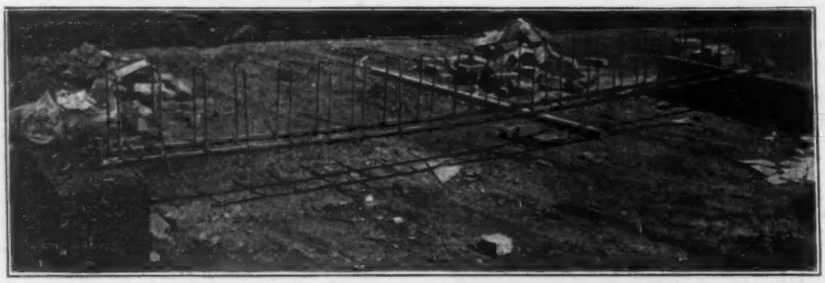


FIG. 1. REINFORCING METAL FOR BEAM OF DRY-LAID BRICKS REINFORCED WITH STEEL.

hard-burned building brick were laid across the two reinforced rods flatwise, in six successive courses. The beam thus was, roughly, 8 ins. wide and 13 ins. high over the brick. It was supported on two wooden blocks to give a clear span of 13 ft. The beam was loaded by a long timber laid across the middle, weighted with brick. Some preliminary experiments with this beam showed the necessity of, first, providing end pressure plates between the turned up portions of the reinforcing rods and the end brick to prevent the crushing of the latter, and, second, placing wooden wedging strips between the successive ranges of bricks, in the joints containing stirrups, to avoid transmitting the entire compression in the brick through the stirrups. A final test was then made which showed a failure load of 3,700 lbs., failure being caused by crushing of the upper layers of brick near the center of the beam.

Considering the weight of the beam (1,000 lbs.), equivalent to 500 lbs. concentrated at the center, the total center load at failure was 4,200 lbs. Calculating the value $M \div bd^2$ for the 8 × 13-in. section, this gives a coefficient of 121; or, in analogy to solid homogeneous beams, the result may be put in the form $M = 726 \times \frac{bd^2}{6}$. The crushing of the bricks at the center shows that the beam developed the full compressive strength of the brick. Comparison of the value for the modulus of rupture here obtained, with the average value of compressive strength of brick found by Prof. Woolson (Eng. News, April 13, 1905), points toward deficiency of reinforcing metal. The test showed clearly, however, that nothing corresponding to shear failure took place, since even close up to the ends of the beam there was no spalling of the brick or slipping of the vertical stirrup.

It was noted in this test that, when the beam was under load, the bricks at the upper end corners of the beam were loose, and therefore idle, while all others were held firmly in place. When the loose bricks were removed the top of the beam had, roughly, the outline of an arch. Of course, as all stress transmitted to the reinforcing rods entered at their ends, the arch action necessarily follows. But it is worth noting, in this connection, that in a recent monograph on "The Role of Adhesive Strength in Reinforced Beams," Mr. F. von Emperger urges that reinforced beams should generally be considered to be concrete arches with steel tie-beams, rather than viewed as direct analogues of the homogeneous "beam."

Following the test of the reinforced brick beam, tests were made on two types of reinforced concrete beams which it is planned to use in a new building about to be erected. One of them was a simple rectangular beam, 6 ins. wide by 22½ ins. deep and 16 ft. in clear span. The other was a ribbed floor construction of special form, designed for a working load of 200 lbs. per sq. ft., on a span of 17 ft. 8 ins. center to center of supports, with a safety-factor of four. Both test objects were tested to destruction, the former under center load and the latter under distributed loading. Deflections were not measured, but the location and character of cracks and of the failure were observed.

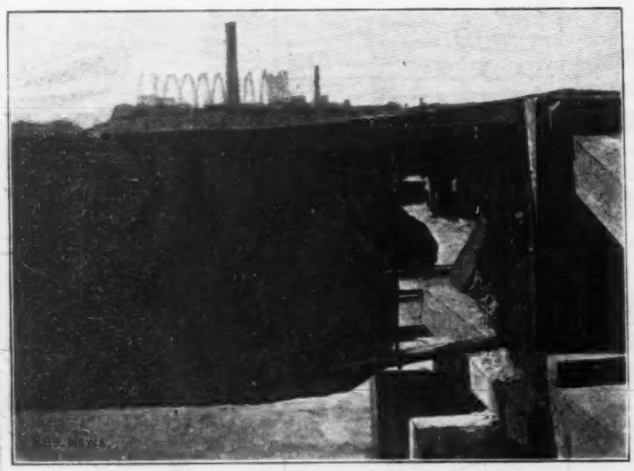


FIG. 4. END OF REINFORCED-CONCRETE BEAM BROKEN BY TEST LOAD.

The rectangular beam had the section and reinforcement shown at A in the accompanying Fig. 3. The reinforcement consisted of six bottom rods, four ⅝-in. and two 11-16-in. in diameter. Four of them were bent up, at distances as shown in the sketch at an angle of 45°, continuing horizontally near the upper surface of the beam to the end. The other rod continued in the bottom for the full length of the beam. Two straight top rods of 1-in. round were used. All rods were turned up 2 ins. at the ends. The concrete in this beam was made of 1 part cement, 2 parts sand, and 5.6 parts roofing gravel, mixed fairly wet, and molded 30 days before the beam was tested.

The beam failed under an applied center load of 13,200 lbs., which with the weight of beam makes an equivalent center load of 14,250 lbs. This corresponds to a value of $M \div bd^2 = 225$, or $6\ M \div bd^2 = 1{,}350$ lbs. per sq. in. equivalent modulus of rupture.

Failure occurred by crushing of the upper side at the center. Almost simultaneous with this, however, was the complete crushing out of a section of the beam at one end, close to the support. Fig. 4 shows this failed portion. The concrete which was broken out here was completely broken up into the condition of fine gravel, no coherent masses being left. This fact, with the fact of the V-shaped ends of the concrete at either side of the hole, is held to show that the end break was a compression failure, and that shear as ordinarily conceived played no material part in producing it. This is supported by the appearance of the opposite end, where a crack appears coinciding, roughly, with that seen in the upper left part of Fig. 4, and curving down thence to the bottom side at the support. The line of this crack is approximately along the line of maximum compression in the end section, and, of course, normal to the line of maximum tension.

The other test was made on two sections of floor of the shape of cross-section shown at B in Fig. 3. Two sections, each comprising one rib (one section is marked off by dotted lines in the sketch), were molded together, with a separator strip at the thinnest point of the beam to form a separation between the two sections. The mixture used was 1:2:4, with crushed trap aggregate. The reinforcement of each rib consisted of two bottom rods, 1-in. round, with 5-16-in. stirrups wound tightly around the rods and extending up to near the top, spaced about 6 ins. apart for a distance of 2 ft. from each end. In the end portions, for a distance of about 3 ft. from each end, a top rod of ¾ in. round was placed, the stirrup being looped around this rod. After the two sections had set 15 days they were mounted side by side about 6 ft. apart, on supports giving a clear span of 16 ft. 10 ins. A distributed load was applied by laying rails across the two beams. Failure occurred by crushing at the center of the top surface. The load at failure was 50,700 lbs., corresponding to a load on the floor as designed of 815 lbs. per sq. ft., which with the dead load of 95 lbs. gives a total loading of 910 lbs. per sq. ft. The appearance of the beams after failure is shown by Fig. 5. The break in the forward beam to the left of the center was caused by the fall and was not a primary break. Cracking in the lower flange was noted, beginning when the live load was about 0.75 of the failure load. The cracks first extended only part way across the lower face, but later extended and ran up the sides, as the load was increased, nearly to the top of the curved sides. No sign of failure near the ends appeared, indicating that the vertical stirrups provided were sufficient for their work of binding steel and concrete together.

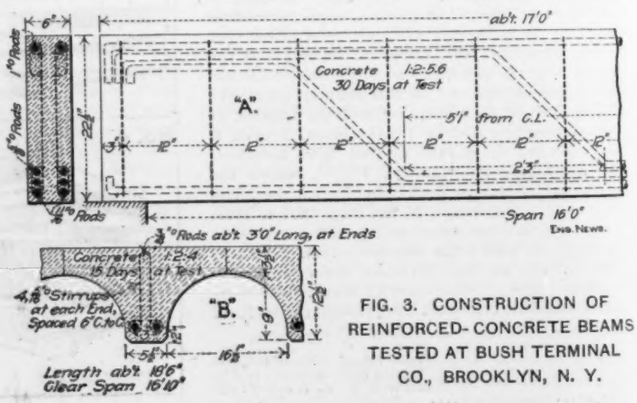


FIG. 3. CONSTRUCTION OF REINFORCED-CONCRETE BEAMS TESTED AT BUSH TERMINAL CO., BROOKLYN, N. Y.

These tests were made at the yards of the Bush Terminal Co., foot of 43d St., Brooklyn, New York City, under the direction of Mr. E. P. Goodrich, Chief Engineer of the company.

HIGH-POWER SURGES IN ELECTRIC DISTRIBUTION SYSTEMS OF GREAT MAGNITUDE.*

By Charles Proteus Steinmetz.†

The following gives a review of a high-power surge which occurred in the high-potential distribution system of the Manhattan Railway, in New York, during the early days of its electric operation. The very complete data on the phenomena occurring during the surge and the effects caused by it have been furnished by Mr. H. G. Stott, at that time Superintendent of Motive Power of the Manhattan system. The surge resulted in a complete shut-down of the power station at 5.50 p. m., July 23, 1903, and again during the following night at 12.45 a. m., July 24, 1903.

FIG. 2. BEAM OF BRICK REINFORCED WITH STEEL AFTER FRACTURE UNDER TEST LOAD.

At 5.50 p. m., July 23, the load on the generating station was 37,000 KW. and was being carried by six 5,000-KW., 11,000-volt, three-phase, 25-cycle generators, Nos. 1, 2, 4, 5, 6 and 7. This power was being transmitted to a sub-station, No. 1, located in the generating station, and also to seven distant sub-stations by three-conductor, lead-covered underground cables, as follows:

To sub-station	No. 2,	6 cables each	27,901 ft. long.
To sub-station	No 3,	5 cables each	14,545 ft. long.
To sub-station	No 4,	5 cables each	18,328 ft. long.
To sub-station	No. 5,	4 cables each	26,191 ft. long.
To sub-station	No. 6,	5 cables each	13,246 ft. long.
To sub-station	No. 7,	5 cables each	9,988 ft. long.
To sub-station	No 8,	4 cables each	27,021 ft. long.

The sub-station high-tension bus-bars were divided into as many sections as there were synchronous converters installed, and at the time of the trouble they were being operated with the section-switches open.

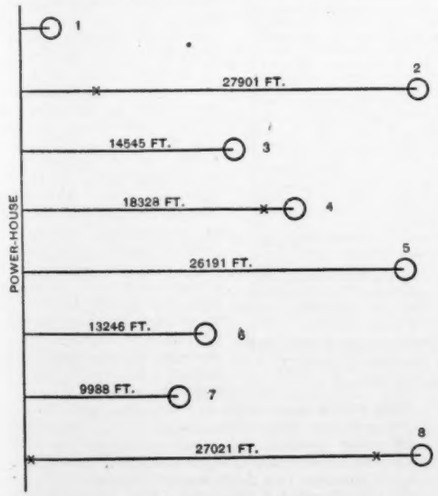


Fig. 1. Diagram of High-Tension Cable System to Substations, Manhattan Ry., New York.

All feeders‡ to sub-stations, except 4-C and 7-C, were protected with static discharges at the power-station end of the cable but not at the sub-station end. The dischargers consisted of nine air-gaps in series with three carbon resistances each of 0.003 megohms. A diagram of the high-pressure three-phase distribution system is given in the accompanying sketch, Fig. 1.

At about 5.45 p. m. sub-station No. 7 notified the power-station that there was quite a lot of static discharge on cables at that station, but that it could not be located on any particular cable. Immediately after sub-station No. 8 made a similar report and then the power-station operator went to the cable gallery to examine static dischargers and try to locate the trouble. He had examined the dischargers on two cables when a loud explosion was heard; whereupon he ran up to the switchboard gallery, and as soon as he arrived there No. 4 generator short-circuited. Two or three seconds before the generator short-circuited a synchronous converter in the power station arced over, and its positive direct-current circuit-breaker opened. This circuit-breaker was arranged to operate on reverse current only. The explosion heard before the generator short-circuited came from a manhole just outside the power-station, and was caused by a cable short-circuiting. When the generator short-circuited, the time limit relays on generators Nos. 1, 2, 4 and 5 opened their respective oil-switches, and the oil-switches of generators 6 and 7 were opened by the switchboard attendant. As these relays were set to operate after three seconds, it is possible that the switchboard attendant opened switches 6 and 7 before the relays had time to act.

On the feeder system the following occurred: Feeder 8-F short-circuited at a joint 243 ft. from the power-station, the three conductors being blown out for about 12 ins.; one leg of the feeder punctured a porcelain insulating tube and grounded in the power-station between the oil-switch and cable-bell. Feeder 8-B broke down at a point 23,980 ft. from power-station; the breakdown showed two legs completely open and the other grounded. Feeder 2-E broke down at a joint 4,800 ft. from the power-station, the break showing one leg open and grounded.

At the power-station the time limit overload relays on feeders 4-E, 4-F, 8-B and 8-F opened their switches; the connections from the main leads to the static dischargers on feeder 4-A, 4-B and 2-F burned off; the walls of the static discharger compartments of 4-B were cracked and sprung, and two small holes were burned in the end-bell on the power-station end of 2-F.

At the sub-stations no damage was done, but most of the reverse-current relays and some overload relays operated, showing that the converters in the sub-stations were feeding back into the cable system.

Careful investigation shows that the following damage was caused by the cables and generator short-circuiting: On generator No. 4, 28 armature bars and 11 connectors at the terminals of machine were broken, bent, or badly burned. On generator No. 1, the insulation at the end of a bar in phase "A" and one in phase "C" was punctured, showing that the pressure had jumped across the intervening air-gap of 4 ins.; the pressure also jumped from an end-connector of phase "A" to the frame, a distance of 6 ins., and a number of overhanging ends of armature bars of phase "C" were slightly bent. On generators 2, 5, 6 and 7 some of the armature bars of phase "C" were also slightly bent, showing excessive current.

In addition to the damage mentioned above, some harm was done to the transformers supplying power for lights in the passenger stations. Step-down transformers, 11,000 to 2,300 volts, for the lighting systems are located at the sub-stations. The current is transmitted to the passenger stations at 2,300 volts and is there transformed to 110 volts. When the cables broke down and the generator short-circuited at the power-station, the fuses blew on nine of the 2,300/110-volt lighting transformers, and on four of them several coils of the high-pressure winding short-circuited.

The damaged parts of the system were cut out, and the power-station and sub-station again started.

On the following night, July 24, at 12.45 a. m., a complete shutdown of the system again resulted from a surge. The load on station at the time was about 3,500 KW., being carried by generators 1 and 5. A short time previous (about midnight) the ground-detectors on the 11,000-volt bus-bar indicated a 10,000-volt ground on one phase. Preparations were at once made to locate the ground by a process of elimination, by cutting out the feeders of each sub-station in turn. Some delay was caused by waiting for the adjacent sub-stations to cut in enough synchronous converters to carry the load of the station cut out. Just as everything was ready to cut out sub-station No. 8, a synchronous converter in the power-station blew its direct-current positive circuit-breaker. Immediately thereafter the following occurred:

Feeder 4-F short-circuited in a section 16,000 ft. from the power-station, burning one conductor completely open and grounding another conductor. The current transformer in one phase of feeder 3-D, and the relay on the transformer, burned out. One main lead from the bell at the power-station end of feeder 3-B burned off for about 2 ins. at a point 7 ins. from the copper sleeve of the joint. The static-discharger lead was connected at this point of main lead. The copper sleeve was found to be loose when the cable was repaired. The static-discharger leads from this cable were burned off, the discharger-compartment division walls were badly cracked and sprung, and a hole 1 in. in diameter and another 4 ins. by 2 ins. was burned in the bell at the power-station end. On feeder 3-A the static discharger leads were burned off, and the discharger-compartment walls were slightly cracked. No damage was done elsewhere to the system.

Regarding this occurrence, Mr. H. G. Stott makes the following comments:

A summary of the happenings of that night in their proper sequence is:

First: A static discharge over the high-tension insulators and cables was observed in sub-stations Nos. 7 and 8.

Second: Within a few minutes a feeder short-circuited in the manhole nearest to the power-station, blowing out about 12 ins. of three-conductor cable, and raising the manhole and pavement all around it with a loud report.

Third: One of the six generators operating in multiple short-circuited near the terminals, conductors on two turns of the winding being driven out until they struck the iron of the frame of the generator; that is to say, the armature bars, which are 2 ins. by ⅛-in., three in each slot, were bent edgewise for over 6 ins., showing that the

FIG. 5. REINFORCED-CONCRETE RIBBED FLOOR CONSTRUCTION BROKEN BY TEST LOAD.

*Abstract of a paper presented before the American Institute of Electrical Engineers at Asheville, N. C., June, 1905.

†Electrical Engineer, General Electric Co., Schenectady, N. Y.

‡Feeders to sub-stations are designated by a number and a letter; the number denoting the number of sub-station and the letter the number of the feeder. For example, feeder 8-F is feeder F of sub-station No. 8.

force bending them probably amounted to at least 3,000 or 4,000 lbs.

Fourth: Practically simultaneously several of the three-conductor feeders to sub-stations 8, 4, 3 and 2 short-circuited, some of them in the manholes at a greater or less distance from the power-station, and some of them on the static dischargers in the power-station, and one across an end-bell in the power-station. No damage took place in the sub-stations.

Upon examination one of the generators, which was apparently otherwise uninjured, showed that the current had jumped across between the end connectors near the end of one phase, a distance of 4 ins., through the air. At another point on another phase of the same machine marks showed that the current had jumped from one of the end bars to the iron through the air, a distance of 6 ins. Other arcing distances showed conclusively that the potential must have risen to not less than 70,000 volts.

The above is a brief resume of what happened.

My own opinion is that the source of all the trouble was in the feeder in the manhole next to the power-station breaking down the insulation to ground; this caused the static to show up at the sub-stations; the large capacity current of the system burned the insulation of the neighboring conductors in the three-conductor cable, and formed a short-circuit which blew out the arc due to the sudden expansion of air in the manhole from the heat generated by approximately 70,000 KW. (each machine being capable of giving out 12,000 KW.). The arc was probably re-established several times, thus setting up an oscillating current, and giving rise to the potential above mentioned.

The most characteristic feature was the enormous volume and relatively very low frequency of the oscillating surge occurring in the system. This explains the severity of the destruction and its widespread extent. Any oscillation of very high frequency could be local only and could not extend over any considerable part of such a system, since the high capacity of the cables necessarily would act as a short-circuit to any very high-frequency oscillation.

The trouble was undoubtedly started in the manhole next to the power-house by a spark discharge between one of the conductors of feeder 8-F and the cable armor, possibly due to the gradual breaking down of a weak spot in a cable joint. This spark discharge between conductor and cable armor, or ground, was oscillating in character, local in extent, and of moderate power and pressure, but of rather high frequency. It was the discharge of a condenser of a pressure equal to the pressure between conductor and ground (that is, the Y-pressure of the system, or about 6,400 volts) and having the capacity and inductance between the cable conductor and ground. The capacity and inductance, however, in this case were distributed.

The length of cable, from the sub-station where the electro-static displays were observed to the point of discharge in the manhole, was 26,780 ft. The estimated capacity between conductor and ground was approximately 0.115 microfarad, and the inductance between conductor and ground 0.106 millihenry per 1,000 ft. of cable, or a total of 3.07 microfarad and 2.83 millihenry, respectively.

An internal electric oscillation on such a line has a fundamental frequency of

$$N_1 = \frac{1}{4\sqrt{L_0 C_0}}$$

with higher harmonics given by

$$N = (2\kappa - 1) N_1$$

where N = frequency in cycles per second.

L_0 = total inductance of line.

C_0 = total capacity of line.

Using the above figures for cable 8-F, which discharged to ground in the manhole near the power-house, it is found that

$$N_1 = 2{,}670 \text{ cycles.}$$

Calling the distance from the fault in the manhole to sub-station 8 a quarter cycle or $\frac{\pi}{2}$, the distance from the fault to any point of the circuit may be expressed by the angle ω.

The spark passing in the manhole, at $\omega = 0$, from the conductor to the cable armor, that is, to the ground, connects the conductor to the ground by an arc. The potential difference E between conductor and ground, therefore, falls to zero, or practically zero, while a current I flows towards the break (at $\omega = 0$) which is the charging current of the system against ground, or about 200 to 300 amperes. With the potential difference E disappearing, the current in the short arc shunted by capacity blows out the arc explosively, and so disconnects the conductor from ground. At the moment when the grounding arc opens, it is therefore: $E = 0$, $I = i_0 =$ constant, in the conductor, at least near $\omega = 0$. The current i_0, still flowing towards $\omega = 0$, produces a potential difference in the conductor, so that as a result of this period, we get zero current: $I = 0$, but a potential difference $E = e_0$, in the conductor, at least at and near $\omega = 0$. This potential difference e_0 again causes a spark to jump at $\omega = 0$, and again grounds the conductor. In the moment when the spark jumps, it is: $I = 0$, $E = e_0$. We have the two periods succeeding each other, the starting condition of each being the final condition of the preceding:

a. From the moment where the arc at $\omega = 0$ ruptures, until a spark restarts it. During this period the conductor is not connected to ground at $\omega = 0$.

b. From the moment where the arc starts at $\omega = 0$, until it ruptures itself again, or while the conductor is grounded at $\omega = 0$.

This results in two oscillations or wave trains, originating at $\omega = 0$, and alternating with each other.

a. Conductor not connected to ground at $\omega = 0$. The duration of this period is the time required for voltage e_0 to jump a spark and ground the conductor. The starting condition, at time $t = 0$ is: $E = 0$; $I = i_0$.

b. Conductor grounded at $\omega = 0$. The duration of this period is the time required by the arc to produce sufficient heat to blow itself out explosively. The starting condition is: $I = 0$; $E = e_0$.

The two wave-trains alternate with each other and so cause a successive series of impulses of high electromotive force but zero current, and of high current but zero electromotive force, to run along the circuit, starting from the fault at $\omega = 0$ and traveling toward the sub-station 8 with such a velocity that the distance from $\omega = 0$ to $\omega = \pi/2$, or 26,780 ft. is traversed during ¼ cycle of the fundamental frequency of oscillation $N_1 = 2{,}670$. This gives a velocity of wave propagation of $4 \times 2{,}670 \times 26{,}780 = 285 \times 10^6$ ft. per sec. = 54,000 miles per second, or about 30% of the velocity of light.

The duration of the successive periods of current and of electromotive force depends on the conditions existing at the starting point of the wave; that is, at the fault in the manhole, but not directly on the constants of the rest of the circuit, and as a rule the duration of the period of high electromotive force and the period of high current are not equal.

As illustrations, the distribution of electromotive force between cable conductor and cable armor are shown in Fig. 2 by dotted line, and of the current flowing in the conductor towards the ground by full line, with the distance along the cable as abscissæ, denoted by the angle ω, and for successive moments of time represented by the angle ϕ, which is chosen so that $\phi = 2\pi$ corresponds to one complete period of the fundamental frequency of oscillation $N_1 = 2{,}670$. The period of high current, or the time from the start of the spark towards ground until the rupture of the arc, is assumed as 21°, and the period of high electromotive force, or the time-lag of the jumping of the spark after the application of the electromotive force, as 16°.

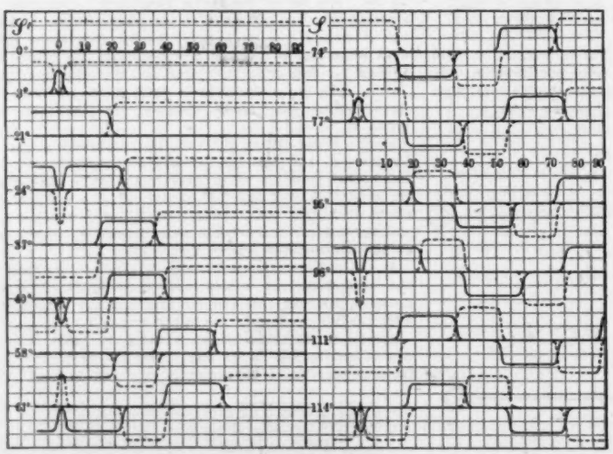


FIG. 2. DIAGRAM OF PROGRESSION OF WAVE-TRAINS OF CURRENT, AND PRESSURE FROM PERIODIC ARC AT A SHORT-CIRCUIT.
(Dotted line represents voltage; full line represents current.)

These two successive wave-trains also constitute a cyclic phenomenon with a period $\phi = 74°$; that is, at $\phi = 74°$ from $\omega = 0$ a second wave issues identical with the wave issuing at $\phi = 0$. A complete period of $\phi = 74°$ of this traveling wave gives a frequency $N_0 = 360/74\ N_1 = 13{,}000$ cycles.

These waves of current and electromotive force which travel along the circuit from the source of disturbance, with high frequency, are in their simplest form flat-topped with steep wave front and back. The steepness of wave front and back depends upon the rapidity with which the arc at $\omega = 0$ establishes itself and ruptures, and also upon the distance ω from the starting point. The latter feature is not shown in Fig. 2, since the resistance and conductance of the line r and g are neglected. Taking them into consideration shows a gradual rounding off of the wave with the increase of distance from the starting point.

Where these waves meet obstructions, as localized inductance, the steepness of the wave front results in the induction of high electromotive forces of very limited extension, and gives the pyrotechnic displays observed at the switchboards of high-pressure stations when there is a disturbance on the line, which sometimes are called "static." Due to their very limited power, these phenomena are relatively harmless of themselves; their danger rather lies in producing or establishing a path for short circuits or surges of high power, as happened in the case under discussion.

Localized inductance offers some protection to the system against these waves even if the inductance is very small. For instance, assuming 11,000 volts and 300 amperes as full-load condition of the feeder cable and an inductance of 0.05 millihenry inserted. This inductance at the impressed frequency of 25 cycles would give a reactance of 0.008 ohms; hence 300 amperes consume 2.4 volts or about 1/50 of one per cent.

Assuming in Fig. 2 the maximum current of the traveling wave as 300 amperes and at the steepest part of the wave to change in strength 250 amperes during $\phi = 1°$ (that is $t = 1{,}300 \times 2{,}670 = 1.04 \times 10^6$ sec.), this gives $d\ i/d\ t = 240 \times 10^{-6}$, and the counter electromotive force which this wave front would meet in such a reactive coil would be:

$$L\ di/dt = 12{,}000 \text{ volts.}$$

I have dwelt somewhat fully on this system of wave trains and the frequency of propagation along the circuit, since I believe this phenomenon of a third frequency, besides the impressed frequency and the frequency of circuit oscillation, has not before been fully recognized. It seems, therefore, that in an electric circuit containing distributed capacity and inductance, as in an underground cable, a long-distance transmission line, or in the high-pressure winding of a transformer or high-pressure generator, three distinct frequencies must be recognized that are essentially independent of one another.

1. The impressed frequency supplied by the generating system, of 25, 40 or 60 cycles as fundamental, and their odd multiples as higher harmonics or wave-shape distortion, which higher harmonics are usually of small or even negligible magnitude.

2. The frequency of oscillation of the system, or natural period of the circuit, depending on the constants of the circuit, mainly the capacity and the inductance, and consisting of a fundamental frequency

$$N_1 = \frac{1}{4\sqrt{L_0 C_0}},$$

and all the odd multiples thereof as higher harmonics. The relative magnitude of fundamental and higher harmonics depends on the distribution of pressure and current in the circuit at the moment where the oscillation starts. As a rule the higher harmonics are not negligible, but usually rather predominate.

3. The frequency of circuit disturbance, which has no direct relation to impressed frequency or to the natural period, but depends upon the character of the disturbance. It appears as a system of waves traveling along the line, and results in the static displays at the end of the line; that is, at the station switchboards. In its simplest form, as a single wave or impulse traveling along the circuit (frequently visible to the eye as a luminous streak), it probably appears when a moderate lightning flash or side discharge strikes a transmission line, and from there to the ground, giving at the point of impact a sudden rise of pressure against ground, immediately relieved by the discharge to ground.

This phenomenon, so far as I know, has never been investigated from the theoretical point of view. While of itself rather harmless, its danger consists in the self-destructive forces that it may set into play. In the circuit under discussion here the impressed frequency is 25 cycles, the natural period 2,670 cycles. The frequency of the static display 13,000 cycles, but of such steep wave front as to correspond to a far higher frequency, possibly of the magnitude of 200,000 cycles per second.

In the breakdown in the Manhattan system, starting with a spark discharge between conductor and cable armor in a faulty joint in the manhole near the power-station, attention was called to the disturbance by the arrival of the wave trains and the resultant static displays on the cables and switchboards of the next sub-stations. No direct harm was done by this "static," but before the fault could be located and cut out, the spark discharge had reached the next conductor of the cable and started a short circuit between two conductors. With six generators of 5,000-KW. rating and a momentary maximum of 12,000 KW. each, and the synchronous converters feeding back into the short circuit, as evidenced by the opening of the reverse-current relays in the sub-stations—it probably is a conservative estimate to assume that for a short period a power of 400,000 KW. was concentrated in the short-circuiting arc in the man-

hole. The energy of 100,000 KW. applied during only one-tenth second equals the explosion of about half a pound of dynamite. The explosion tore off the insulation and protection of the conductor, and a flaring arc started in the manhole, and being oscillating or self-restoring in character, created a surge of low frequency and enormous power in the whole system, beyond the destructive strength of any part of the system or any protective device. This short-circuit oscillation was a surge of the whole system throughout, and almost instantaneously caused all the breakdowns in feeders, cables, cable-bells, transformers, generators, etc. The static protectors apparently discharged and somewhat lowered the pressure, but could not be expected to take care of the enormous volume of the surge. Some burned up explosively due to the excessive pressure imposed upon them.

From the data available I estimate the capacity of the system between two conductors as 76 microfarads. Assuming that the short circuit current or synchronous impedance current of these generators at full pressure and no-load excitation is about three times full-load current or approximately 800 amperes, gives a synchronous impedance of 8 ohms Y. We may probably assume that somewhat less than one-half of this is self-inductive reactance participating in the oscillation, and that the rest is armature reaction. With the understanding that there is some reactance in the station wiring, current transformers, etc., we may assume the self-inductive reactance per generator as about x=4 ohms, corresponding to an inductance of 25.5 millihenrys. The self-inductance of the six generators in circuit during the accident then is: 4.25 millihenrys. Allowing 0.25 millihenrys for effective resultant inductance of the cable system gives a total inductance: L=4.5 millihenrys. The fundamental frequency of the surge of the whole system would be:

$$N_o = \frac{1}{2\pi\sqrt{LC}} = 270 \text{ cycles, or quite low.}$$

With C = 76 microfarads, L = 4.5 millihenrys, and $e = \frac{11{,}000}{\sqrt{3}} = 6{,}340$ volts per phase, the instantaneous short-circuit current or the volume of the surge would be:

$$i_s = e/2\pi N L = 9{,}000 \text{ amperes.}$$

where N = impressed frequency, and the pressure of oscillation:

$$e_o = 2\pi N_o L i_s = 68{,}800 \text{ volts per phase,}$$

or 119,000 volts between lines, where N_o = frequency of oscillation.

With such a volume of surge all breakdowns that occurred would also be oscillating and therefore would not relieve the system by discharging the oscillation, but set up secondary oscillations.

Thirty-two static protectors of 0.003 megohms each, hence of a total delta resistance of 282 ohms, and a Y-resistance of 94 ohms, would, at 100,000 volts delta or 58,000 volts Y, carry off about 630 amperes or 7%, and therefore lower the pressure of oscillation by 7%, that is, to about 110,000 volts between lines, but they would be loaded far beyond their capacity, as evidenced.

As seen, the most prominent features of the surge seems to have been its enormous volume and relatively low frequency, which account for its very wide extent and destructiveness.

From another phenomenon we can also estimate the approximate frequency of the surge. The burning out of the fuses of some 2,300-volt transformers without destruction of these transformers is explained by assuming that the high-pressure oscillation penetrated to these transformers and that their primary pressure rose so as to bring the iron of the transformers beyond magnetic saturation and blow the fuses by the excessive exciting current, due to magnetic saturation. This did not occur in the 11,000-volt transformers, which were operating at lower magnetic density; while the 2,300-volt transformers, built originally for higher frequency, were operating normally at fairly high density on the 25-cycle circuit. From this we may estimate the frequency of the surge. 25-cycle transformers are necessarily operated at fairly high magnetic density, so that increasing the normal magnetic density two or three-fold results in such high saturation as to blow the fuses by the exciting current. The magnetic cycle of the surge is superimposed upon the normal magnetic cycle of the transformer. It then depends at what point of the normal cycle the abnormal cycle started. If at the maximum point, an abnormal cycle of one-half the amplitude of the normal cycle would double the density and so saturate. If at the negative maximum point, an abnormal cycle would have two times the amplitude of the normal to treble the density. The most probable is that the abnormal cycle or the surge started near the zero point of the normal cycle or near the maximum point of the circuit pressure and then at 1.25 times the amplitude of the normal cycle the abnormal cycle would increase the density 2.5 times. Assuming from the striking distance a pressure of 80,000 for the oscillation, or 7.2 times normal pressure, to give an abnormal cycle of 1.25 times the amplitude of the normal cycle would require a frequency of 9.0 times the normal frequency or 225 cycles respectively. The frequency of oscillation therefore would probably be in the neighborhood of 225 cycles.

The shutdown of the generating station ultimately stopped the surge. I should believe it quite possible, however, that besides the breakdowns which have been observed by their destructive effect, some more breakdowns have occurred lasting so short a time before the taking off of the generating system as not to cause any noticeable destruction, and merely weakening and partly breaking down the insulation. The breakdown occurring again towards midnight I attribute to such a partial breakdown, which was completed by some small oscillation as the opening of a converter circuit-breaker.

Two years have passed now, and I believe no further surge of this magnitude has occurred, and a protection of the system has been devised.

ESTIMATES FOR A MUNICIPAL ELECTRIC LIGHT PLANT FOR PUBLIC LIGHTING, NEW YORK CITY.

Municipal electric lighting in New York City can be secured at a great saving over the prices now paid private companies for gas and electricity, according to a report submitted to the Board of Estimate and Apportionment on June 19 by the Commission on Electric Lighting:* The estimated cost of arc lamps is $64.07 for 7.5 ampere, enclosed arc lamps, requiring about 480 watts at the lamp terminal, and 5.5 cts. per kilowatt hour for incandescent lamps. The annual saving effected by the municipal electric plant as compared with the payments now made for the mixed gas and electric service, would be $434,000 a year, but if electric lights to replace the many gas lamps now used were contracted for at the ruling Edison prices the saving due to the municipal plant would be $1,481,000 a year, or about 20% on the entire investment required for the proposed works.

One paragraph in the introduction to the present report will disappoint those who claim that American cities can be lighted or even partly lighted by the heat generated from refuse destructors or furnaces. The commission says:

> We believe that the use of city wastes as fuel for this plant would be entirely impracticable, this opinion being based on preliminary estimates.

The proposed lighting plant would serve the boroughs of Manhattan and The Bronx, only, but in those boroughs would supply light for all the streets, parks, public places and city buildings. At present 290 miles of streets are lighted by electricity and 442 by gas and naphtha. The gas lighting embraces about 28,000 Welsbach mantle lights. Including motors now used in some of the city buildings allowance has been made for the equivalent of 300,000 16-c.p. incandescent lamps. These, with the 15,000 arc lamps proposed, require a 15,000-KW. station.

A single central station for the two boroughs is proposed, generating electricity at 11,000 volts, and nine substations in Manhattan and five in the Bronx. There would also be centers of distribution which would receive current at 2,200 volts and transform it to 230 volts for delivery to buildings by means of three-wire branch circuits. Inter-connections between the Manhatttan and Bronx central station and a proposed Queens and Brooklyn central station, and also between each substation of each system and the central station of the other system is also proposed.

A complete underground distribution system for Manhattan is proposed, using without charge, under contract provisions, the existing electrical subways. In the Bronx the main cables leading to the substations would be underground and the further distribution overhead, using as far as possible, under rental now provided for in contracts, the poles of electric light and telephone companies.

The plans call for a building sufficient for 20,000 KW., with 15,000-KW. equipment, using water tube boilers, steam turbo-generators and distribution by oil switches. Most of the auxiliaries would be steam driven. Duplicate exciter sets are proposed and also a storage battery for excitation.

Coal storage for 20,000 tons in the yard, in covered bins, is provided, besides the bunkers over the boilers. This would be sufficient for six months' use.

The block bounded by the East River, 90th and 91st streets and Ave. A. has been bought by the city and is ample for the proposed plant and extensions.

On the principal streets of Manhattan the present iron poles would be duplicated. Elsewhere poles with most arms to bring the light over the street are proposed. The commission believes that all but the larger city water pumping stations could be more economically operated by electrically driven centrifugal pumps than by the present methods.

The total cost of the proposed plant is $7,567,000. Of this $5,269,000 is for the arc and $2,298,000 for the incandescent lighting; or $352 per arc lamp and $153 per kilowatt of connected loads for incandescent lamps.

The annual output of the station would be 36,000 KW. hrs. for arc and 7,000,000 for incandescent; or, assuming 80% delivered at the lamp terminals, 28,800,000 and 5,600,000; respectively.

The 43,000,000 KW. hrs. at the power house at 0.7 cts. per KW. hr. would cost $301,000; maintenance, repairs and inspection of distribution, $125,000; management, $50,000; making a total of $476,000, or 1.384 cts. per KW. hr. for the 34,000,000 KW. hrs. delivered to the lamp.

Arc lamps for one year would cost as follows: Electric energy 1,920 KW. hrs. at 1.384 cts., $26.57; maintenance, $8; depreciation, $17.21; interest, $12.29; total $64.07. Incandescent lamps would cost, in cents per KW. hr.: Energy, 1.38; maintenance, 0.75; depreciation, 1.93; interest, 1.44; total, 5.5 cts. The total yearly operating and fixed charges would be $1,269,000; or $961,000 for 15,000 arc lamps at $64.07 and $308,000 for 5,600,000 KW. hrs at 5 1-2 cts.

The unit prices being paid at the date of the report were $146 for arc lamps and 10 cts per KW. hr. for incandescent lights, which if applied to the increased service proposed would require a total yearly payment of $2,750,000. At present two-thirds of the street lighting and half of the lighting of public buildings is by gas, the relatively lower rate of which brings the total charges for public lighting down to $1,703,266.

In the foregoing estimates interest is taken at 3 1-2 per cent. on the total capital outlay, except real estate, engineering and contingencies and interest during construction; depreciation, with the same exceptions, is figured at 6 per cent. In the estimates of February, 1905, an allowance of 8 per cent. was made for depreciation. The present lower figure, the commission states, is now believed to be more nearly correct, "in view of the present state of the art."

The report, which is accompanied by full specifications, comprises 135 pages of text and a few plates showing plans, elevations and sections of the central station.

*Cary T Hutchinson, M. Inst. E. E., 56 Pine St., Chairman; Nelson P. Lewis, M. Am. Soc. C. E., Chief Engineer Board of Estimate and Apportionment, Secretary, and Prof. Geo. W. Sever, M. Inst. E. E., Columbia University. The present report is styled Report B. The first report of the commission, or Report A, was dated Feb. 10, 1905, and was abstracted briefly on p. 177 of Engineering News for Feb. 16, 1905. It contained estimates for the construction and operation of a plant similar in most respects to the one now reported on, except that it did not provide for replacing by electric lights the gas lamps now in use in lighting many of the streets of the city. The earlier estimate, for 6,000 arc lamps burning 4,000 hours a year, including capital charges, was $75.40 each per year, as compared with the $64.07 each for 15,000 arc lamps in the present estimate. The earlier depreciation charge was 8%, against 6% now allowed (our note, cited above, gave depreciation at 7.5%).

FAILURES OF LAKE AVALON DAM, NEAR CARLSBAD, N. M.

By E. C. Murphy,* Assoc. M. Am. Soc. C. E.

Two failures of the Lake Avalon Dam have occurred within a dozen years. The dam is located on the Pecos River, about six miles from the town of Carlsbad, N. M., and was built to form a storage reservoir for irrigation purposes. The dam, as reconstructed after the first failure, was a composite structure of loose rock, with earth on the upstream side. The total length was 1,380 ft. and the maximum height was 48 ft. The loose

*Engineer U. S. Geological Survey, Washington, D. C.

rock part had a top width of 10 ft., inside slope ½ to 1, laid by hand; down-stream slope, 1½ to 1, laid by hand. The earth part had a top width of 10 ft. and a slope of 3½ to 1, riprapped 1 ft. thick.*

The right bank of the river at the dam is a conglomerate, the left bank is limestone, and the river bed is mixed well. The loose rock used in the dam was the conglomerate taken from the right bank. It is mainly chunks, 6 to 18 ins. in diameter, with much fine material. It was dumped in place by carts. The earth used was a sandy loam containing some clay obtained near the dam. It was put in place with carts and scrapers and consolidated by the travel of teams and vehicles over it.

LAKE AVALON DAM, AUG. 6, 1903, AFTER THE FIRST FAILURE.

There are three wasteways; one at each end, and the other on the right bank about one-half mile from the dam. The principal one was located on the limestone, on the right bank, and was provided with gates. Its discharge capacity for a water height of 23 ft. or 7 ft. below the crest of the dam was 16,900 sec. ft. Spillway No. 1 had a capacity of 5,600 sec. ft.; No. 2, 7,300 sec. ft.; head gates of canal 3,200 sec. ft. The total discharge of the wasteways when the water surface in the lake was 7 ft. below the crest of the dam was 33,000 sec. ft.

The reservoir when filled to the 23-ft. level had a length of about five miles and a maximum width of 1½ miles; it submerged an area of 1,980 acres and had a capacity of 6,300 acre-feet.

The dam was built in 1894 on the site of the composite loose rock and earth dam that failed during the flood of August, 1893, when the maximum discharge of the Pecos River at this place was 43,000 sec. ft. The first dam had a lighter cross section than the second and had only one spillway. An old photograph of the original dam, taken just after the failure, is reproduced herewith.

The second failure occurred 11 p. m., October 1, 1904, during a flood of unprecedented magnitude, the rate of flow at this place being, according to the estimate of Mr. V. L. Sullivan, Engineer of the Pecos Valley Irrigation Co., 82,00 sec. ft. It failed by the water forcing a passage through the dam, not by flowing over the top, but the height above the bed where the earth facing failed could not be ascertained.

*The original dam was briefly described in Engineering News of May 17, 1890; the dam as reconstructed in 1894, together with a dam higher up the stream and other parts of the irrigation system to which both dams belong, were described and illustrated in Engineering News of Sept. 17, 1896. It appears that the dam which is the subject of this article was originally known as the Eddy dam and that the town of Carlsbad was formerly named Eddy. The dimensions of the reconstructed dam given in the last-named issue differ somewhat from those stated in this article, but the latter were taken from a blue-print supplied to Mr. Murphy by an official of the company. —Ed.

Mr. F. G. Tracy, President of the Pecos Valley Irrigation Co., was at the dam at the time of its failure, and states that the water reached a height of about 3 ft. below the crest of the dam and remained nearly stationary for a few hours. He thought the danger of failure was over, but shortly after the lake surface at the dam dropped rapidly 3 ft. He went out on the dam with a lantern and heard the water roaring through the dam, but the crest had not settled. The water continued to fall for some minutes, and then appeared to rise for a short time, after which the dam gave way. A piece about 450 ft. long at the crest and 400 ft. at the base was washed out.

There are two opinions as to the cause of the failure. One is that animals burrowed into the earth part of the down-stream side and weakened the earth facing; the other is that the failure occurred near the base at the right end. There was some leakage at the right end and efforts were made to stop it by sheet piling, but without complete success, but whether the failure was due to animals burrowing in the earth face and weakening it or faulty connection of the dam with the right bank cannot be ascertained, as the failure occurred in the night.

The flood waves caused by the failures of both dams were large. The failure of the first one, in August, 1893, swept away the flume that carried the water for irrigation across the Pecos River and all bridges in Carlsbad. The failure of the second dam damaged the flume, swept away the three bridges, cut a new channel around the dam at Carlsbad, and eroded the channel to a considerable extent. It is said that the channel in the vicinity of Carlsbad is twice as wide at the present time as prior to the flood of 1893.

Nine miles above Lake Avalon dam is located McMillan dam, a somewhat larger composite structure, having a maximum height of 52 ft. and a crest length of 1,686 ft. The side slopes and top width are the same as those of Lake Avalon dam, but the top width of the loose rock part of the larger structure is 14 ft. and the earth part 6 ft. The dam was not damaged by the flood, but fears were entertained for its safety, as its spillways were raised a few feet a short time prior to the flood.

The writer is indebted to Mr. B. M. Hall, Supervising Engineer, U. S. Reclamation Service, and to Messrs. F. G. Tracy, H. Christian and V. L. Sullivan, officers of the Pecos Valley Irrigation Co., for some of the information used in the preparation of this paper.

A FAST SPECIAL TRAIN on the Lake Shore & Michigan Southern Ry. made the trip from Buffalo to Chicago, on June 12, and back to Buffalo on June 13, making an average speed of about 70 miles an hour each way (excluding stops) for the entire run of 525 miles. The train consisted of two private cars and a day coach, weighing about 58 tons each, or 175 tons in all. Four engines were used on each trip, and their dimensions were as follows:

Type	2—6—0	2—6—2	4—6—0
Weight of engine	175,000 lbs.	238,000 lbs.	171,600 lbs.
Weight on drivers	130,000 lbs.	165,000 lbs.	133,000 lbs.
Weight of tender	124,500 lbs.	156,000 lbs.	124,500 lbs.
Cylinders	20½ x 28 ins.	21½ x 28 ins.	21½ x 28 ins.
Driving wheels	6 ft. 8 ins.	6 ft. 7 ins.	6 ft. 8 ins.
Boiler pressure	200 lbs.	200 lbs.	200 lbs.

The following summary of the two trips has been kindly furnished to us by Mr. H. F. Ball, Superintendent of Motive Power of the Lake Shore & Michigan Southern Ry.:

Westbound: Buffalo to Chicago, June 12.

	Time.	Time of run.	Distance miles.	Av. speed miles per hour.
(Engine 4692: 2—6—0)				
Lv. Buffalo	5.15 a.m.	.....	.....	.....
Arr. Cleveland	7.50 a.m.	2h. 33m.*	183	70.80
(Engine 4665: 2—6—0)				
Lv. Cleveland	8.00 a.m.	.....	.....	.....
Arr. Toledo	9.33 a.m.	1h. 33m.	108	69.09
(Engine 5003: 4—6—0)				
Lv. Toledo	9.36 a.m.	.....	.....	.....
Arr. Elkhart	11.30 a.m.	1h. 54m.	133	70.00
(Engine 695: 2—6—0)				
Lv. Elkhart	11.33 a.m.	.....	.....	.....
Arr. Chicago	1.05 p.m.	1h. 32m.	101	65.86

*Including a two-minute stop at Erie.

Average speed, including stops, 67.02 miles per hour.
Average speed, excluding stops, 69.69 miles per hour.

Eastbound: Chicago to Buffalo, June 13.

	Time.	Time of run.	Distance miles.	Av. speed miles per hour.
(Engine 695: 2—6—0)				
Lv. Chicago	6.50 a.m.	.....	.....	.....
Arr. Elkhart	8.22 a.m.	1h. 32m.	101	65.86
(Engine 4661: 2—6—0)				
Lv. Elkhart	8.24 a.m.	.....	.....	.....
Arr. Toledo	10.18 a.m.	1h. 54m.	133	70.00
(Engine 4665: 2—6—0)				
Lv. Toledo	10.20 a.m.	.....	.....	.....
Arr. Cleveland	11.51 a.m.	1h. 31m.	108	71.20
(Engine 3707: 2—6—2)				
Lv. Cleveland	11.53 a.m.	.....	.....	.....
Arr. Buffalo	2.23 p.m.	2h. 30m.*	183	73.20

*Including a three-minute stop one mile east of Dunkirk.

Average speed, including stops, 69.53 miles per hour.
Average speed, excluding stops, 70.94 miles per hour.

THE WORKING FORCE ON THE PANAMA CANAL now numbers 7,600 men, of whom about 1,200 are Americans.

THE CONCRETE BLOCK MACHINE MANUFACTURERS' ASSOCIATION.

This new association was organized and held its first annual meeting at the Great Northern Hotel, Chicago, June 27, 28. About 35 or 40 persons were present at the meeting. Mr. S. L. Wiltse, of Jackson, Mich., was elected President and Mr. O. U. Miracle, of Minneapolis, Minn., was elected Secretary. The association is to be composed of manufacturers of machines and owners of processes for the production of concrete blocks for buildings, concrete pipes, etc. At the morning meeting, on June 27, the preliminary organization was effected, and two committees were appointed, one to deal with the organization and credentials, and the other to draw up a constitution and by-laws.

At the afternoon meeting Mr. O. U. Miracle presented a short paper on "The Position of the Block Machine Manufacturer in Relation to the Public." He stated that there are now some 4,000 makers of concrete blocks and about 100 makers of machines for molding these blocks. He strongly advocated the preparation of specifications which will meet the approval of architects and engineers, as the people who buy and use the machines know little about concrete, but look to the machine makers for information, and any failures due to bad material or work will injure the business. A rather serious trouble is the employment of incompetent salesmen, who will tell any kind of story in order to make a sale. Some have told their customers that blocks can be made one day and used the next day; while others state that the concrete need have but 1 part of cement to 15 or 20 parts of the aggregate, or that "as long as any cement is used the concrete is all right."

A general discussion followed as to the manufacture of concrete blocks; this was somewhat desultory, but related mainly to the waterproof properties of the blocks. Various opinions were

expressed as to the use of a richer mixture for the face or a uniform mixture throughout, and whether to make the concrete dry or wet. Mr. Krottnaurer (Chicago) said that a great deal depends upon the quality or porosity of the stone used. Some of the so-called waterproof cements are not permanent or are otherwise unsatisfactory, but with long experimenting he has perfected a solution which he adds to the concrete and which makes the blocks shed or reject water the same as pressed brick. Mr. F. Dykema (Jackson, Mich.) uses a cement face (with blocks molded face upward), and to give the face a good appearance, he sprinkles fine sand over it. Mr. N. F. Palmer (Brooklyn, N. Y.), thought a waterproof compound applied to the face of the finished block would be preferable, but Mr. Krottnaurer considered that this would be more expensive and less satisfactory. The use of concrete for reservoirs and for water pipes under pressure was referred to, but it was pointed out that the conditions in regard to concrete blocks are very different. Mr. Dykema then read a paper on "Architecture of Concrete Block Building," in which he argued that the blocks should not be considered as artificial stone, and for this reason (among others) he objected to the common use of rock-face blocks. Coloring can be used for decorative effects, and is an important matter. Mr. N. F. Palmer gave a talk on his experience, which began at a time when the building department of Brooklyn refused to sanction the use of concrete blocks; he supplemented this with a review of the early history and patents of concrete block manufacture. Mr. L. F. Normandin (Jackson, Mich.) followed with a short talk.

At the morning meeting, on June 28, Mr. S. L. Wiltse (Jackson, Mich.) read a paper on "Concrete Block Insurance," and this was followed by one on "What the Underwriters and the National Fire Protection Association are doing with Regard to Concrete Blocks from an Insurance Point of View," by Mr. E. T. Cairns, Chairman of the committee on cement for building construction, appointed by the National Fire Protection Association. These papers opened up a brisk discussion as to the fireproof properties of concrete blocks, in which different members cited buildings of concrete blocks which have sustained severe fires with practically no damage to the blocks. In one of these cases, the fire occurred in a room stored with toys packed in excelsior, and the heat was very intense, while streams of water were directed on the hot walls without causing any injury. Mr. Hotchkiss (Chicago) has built the flues of brass furnaces of concrete blocks; here the temperature reaches 3,200 to 3,700° F. and the furnaces are shut down at night and from Saturday to Monday. Yet after eight weeks service there has been no damage due to the direct heat, or to the intermittent heating and cooling. It has been claimed that limestone concrete will not stand heat, but these blocks are made with crushed limestone.

The appointment of a committee to prepare specifications for the manufacture of concrete blocks was advocated by Mr. Miracle, as a means of improving the product, and several members spoke of the injury done to the trade by the construction of cheap buildings with bad blocks and scamped workmanship. Mr. Palmer considered that most architects would draw up their own specifications and that the Association should not undertake to specify the ingredients, proportions, methods of mixing, etc. Mr. J. P. Sherrer (Milwaukee, Wis.) thought it would be quite impracticable to prepare general specifications, owing to the varying character and quality of material in different localities. For instance, of two kinds of limestones from quarries in the same district, one is excellent and the other quite unfit for use in concrete; and proportions of 1 to 6 in one place may make a better concrete than proportions of 1 to 3 in another place. He did not think that engineers could yet write specifications for concrete for building blocks, in spite of their experience with concrete in other lines of work. Other speakers suggested that instead of specifying the mixture, etc., there should be specified tests for completed blocks, and the new rules of the New York Building Department were cited, which specify a fire test of 1,700° F. and an ultimate compressive strength of 3,000 lbs. per sq. in. Mr. C. C. Brown (Indianapolis, Ind.) pointed out that the government is commencing a series of tests of building materials, including cement and cement products; these are under the general supervision of an advisory board composed of members from various technical associations, and much of the work will be done at the engineering schools. He thought the only satisfactory way for the association to proceed would be to appoint a committee to co-operate in this work and report the results. This action was eventually taken.

At the afternoon meeting Mr. J. P. Sherrer (Milwaukee, Wis.) read a paper on "The Coloring of Concrete Blocks." He has experimented considerably in this line, using various compositions, and considers the iron oxides (red, yellow and buff) to be most satisfactory. Sample briquettes must be made and thoroughly dried to show the final color, and the mixing should be very carefully done, water being added as a spray so as not to wash the coloring matter from the cement. The colors do not fade, but owing to the action of lime in the cement they become lighter until the concrete has thoroughly dried. After that, the tendency is to get rather darker with age. Delicate tints are more satisfactory than pronounced colors, but there is less demand for coloring now than there was a few years ago. He has made white blocks by the use of marble dust and ground white quartz; he has also made them of sand, cement and hydrated lime by the same process employed for sand-lime brick. There was then a short discussion as to the advisability of applying plaster directly upon the inner surface of concrete blocks. Several members have done this with success, but unless the blocks are well made and laid there may be trouble, and they do not recommend the practice.

By special invitation some members of the technical press made brief addresses as to the relations of the press to the concrete block industry, and reference was made to the prizes offered by Engineering News for papers on the manufacture of concrete blocks. The meeting ended with a brief discussion as to securing special freight rates on railway shipments of blocks and block machines.

72,000,000-GALLON PUMPING ENGINE AT BOSTON, MASS.

A pumping engine which is believed to be the largest reciprocating pump* in the world has recently been built and installed for the Boston Main Drainage Works, of the Sewer Division, Boston, Mass. The engine is of 72,000,000 gallons capacity for 24 hours, working against a head of 40 to 45 ft. The power represented by this performance, not far from 500 HP., is small compared with the power concentrated in single units used for many other purposes: rolling-mill work, electric power generation, and, above all, ship propulsion. But the quantity of water handled in a given time by this pump is greater than that moved by any pumping engine previously constructed, and this feature renders the machine worthy of special attention. Its exceptional capacity, and the fact that the pump handles not water but sewage, causes interest to reside mainly in the water end. The drawings of the pump herewith presented exhibit the general arrangement of parts and the principal features of construction of the engine. A longitudinal section and plan of the engine are shown in Fig. 1, a transverse section in Fig. 2. Figs. 3, 4 and 5 show some details to be referred to later.

The Main Drainage Works of the city of Boston, Mass., which have been in operation for twenty years, consist of a system of intercepting sewers that drain a network of combined sewers. The interceptors are for the purpose of providing means to discharge the normal sewage flow into tidewater at some distance from the city, in order to give better conditions in the harbor than when the sewers discharged directly into the bay. The existing gradients are insufficient, however, to allow the interceptors to discharge by gravity at the desired outlet. Pumping of the flow is therefore required. The interceptors are connected by a main drainage sewer, which leads the sewage to a pumping station at Calf Pasture. Where the common sewers are tapped by the interceptors, automatic regulators are provided which turn the excess flow during rain storms into tide-water

*The propeller pump of the Milwaukee, Wis., flushing tunnel has a capacity over seven times as great, 525,000,000 gallons per day. Its lift is about 5 ft.

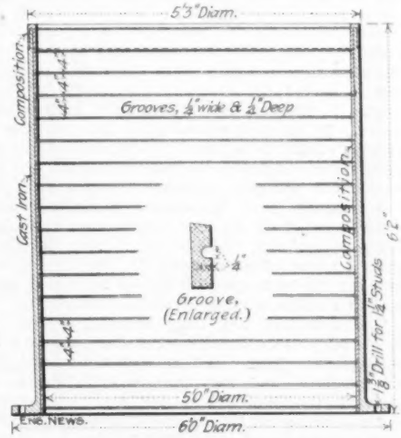


Fig. 3. Packing Sleeve for 60-in. Plunger.

through the old sewer outlets; tide-gates are provided at these outlets to protect the system from the effects of rise and fall of tides. The normal sewage flow, and indeed the entire flow up to the capacity of the pumping station, is taken by the intercepting sewers. The sewage is lifted by the pumps a height of some 40 ft. to a reservoir of 50,000,000 gallons capacity, lying sufficiently high above tide-level to give free gravity flow. Here it is held until the outgoing tide, and then is discharged into tide-water.

The sewage pumping station at Calf Pasture contains two low-duty Worthington pumps, each of a capacity of 25,000,000 gallons per 24 hours; two high-duty pumps designed by Mr. E. D. Leavitt, each of capacity of 42,000,000 gallons per 24 hours; and the 72,000,000-gallon pump here described, which is the latest addition to the pumping equipment. The capacity of the station has thus been increased by over 50 per cent. in adding the new pump.

This pumping engine is, in the steam end, a triple-expansion engine with three vertical inverted cylinders, 18½, 33 and 52¾ ins. by 120 ins. stroke. As may be seen from the plan in Fig. 1, the cylinders are set in two groups, high and intermediate pressure cylinders forming one group, and the low-pressure cylinder the other. The water end comprises two vertical pumps set directly below the two groups of steam cylinders,

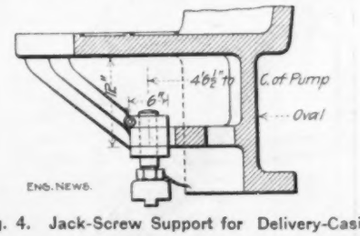


Fig. 4. Jack-Screw Support for Delivery-Casing.

and having their plungers connected directly to the piston-rod crossheads of the two groups. A walking-beam, connecting-rod and fly-wheel are provided for equalizing the motion. The steam cylinders are carried on a massive entablature which is supported by four columns fitted with diagonal braces, all of cast iron. Centrally to the grouping of cylinders, and immediately above the floor level, lies the walking-beam shaft, carrying a double cast iron walking-beam whose ends are linked by double rods to the long piston crossheads. A connecting-rod passes upward from a pin in the walking-beam to a crank pin on the fly-

wheel shaft. This latter shaft lies well above the floor level and rests in two bearings—one in the entablature of the engine frame and another carried on an independent outboard pier, as may be seen in Fig. 2.

The steam valves are flat gridiron slide valves working in valve chambers transverse to the axis of the cylinders. A cam gear actuates these valves. The cam-shaft serving intermediate and low-pressure cylinders lies at right angles to the crank shaft, at the level of the bottom of the cylinders. It is actuated by miter-gears from a short lay-shaft lying in the continuation of the crank-shaft axis and driven by a return crank from the main crank pin. This may be seen from the plan view in Fig. 1. The high-pressure cylinder is served by a second cam-shaft, at right angles to the first and driven from it by miter-gears. In the first cam-shaft is inserted a jaw-clutch; when this is thrown out it disconnects the mechanism actuating the valves of high and intermediate pressure cylinders, leaving only the low-pressure gear in action. A fly-ball governor, located on the engine-base near the high-pressure cylinder, is belt-driven from the main shaft by way of a countershaft (see Fig 1), and governs the high-pressure cut-off by means of a governor rod extending up to the cam shaft.

The cylinders are fully steam-jacketed, on heads as well as barrels. Tubular reheaters lie between the high and intermediate and the intermediate and low-pressure cylinders, as is shown in the plan. All hot surfaces in the steam end are protected by a non-conducting covering, with cast-iron and sheet-steel lagging for finish.

The engine is fitted with an attached condenser of jet type, located at one corner underneath the main base casting, and hung from girders which span the pit adjoining the main pump well. The air pump is a vertical single-acting bucket pump, driven by links and a rocker shaft from the main walking-beam (at the left in Fig. 2).

The pumps are single-acting plunger pumps 60 ins. in diameter, with 10-ft. stroke. Their general disposition is fully shown by Figs. 1 and 2. Practically the entire surface of the pump cylinders is utilized as valve-seating. The suction part, below, hangs directly in a wet-well formed in the foundation masonry. Screens are provided in the pump-wells to catch solid material that may pass the sewer screens. The upper or discharge portion is surrounded by a delivery-casing which serves also as air-chamber. The delivery-casings of the two pumps are connected together, and discharge into two 48-in. delivery mains leading out in opposite directions. The delivery casings serve also as air-chambers.

Each pump consists of 12 principal castings,

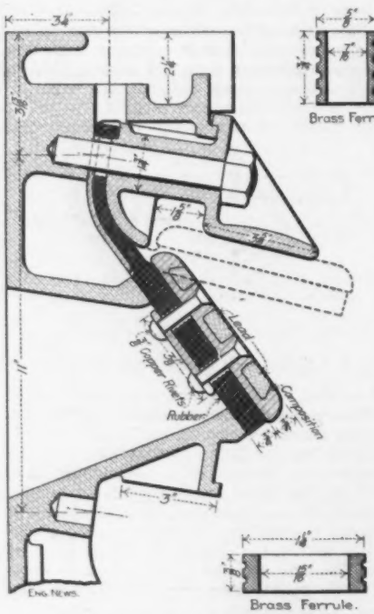


Fig. 5. Valve, Seat and Guard.

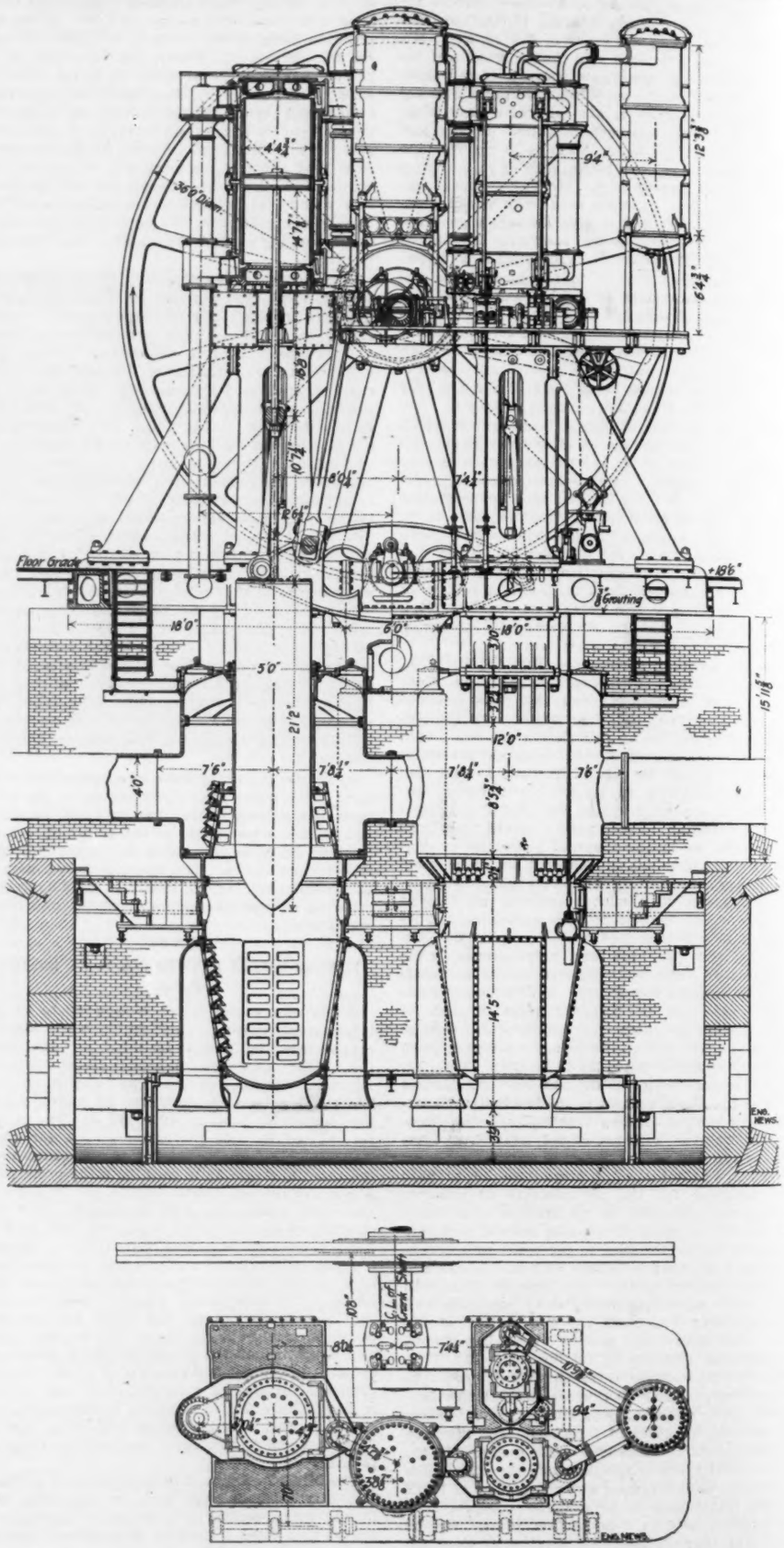


FIG. 1. PLAN AND LONGITUDINAL SECTION.

FIGS. 1 AND 2. PLAN AND SECTIONS OF 72,000,000-GALLON SEWAGE PUMPING ENGINE, CALF PASTURE PUMPING STATION OF THE MAIN DRAINAGE WORKS, OF BOSTON, MASS.
E. D. Leavitt, Designer. I. P. Morris & Co., Builders.

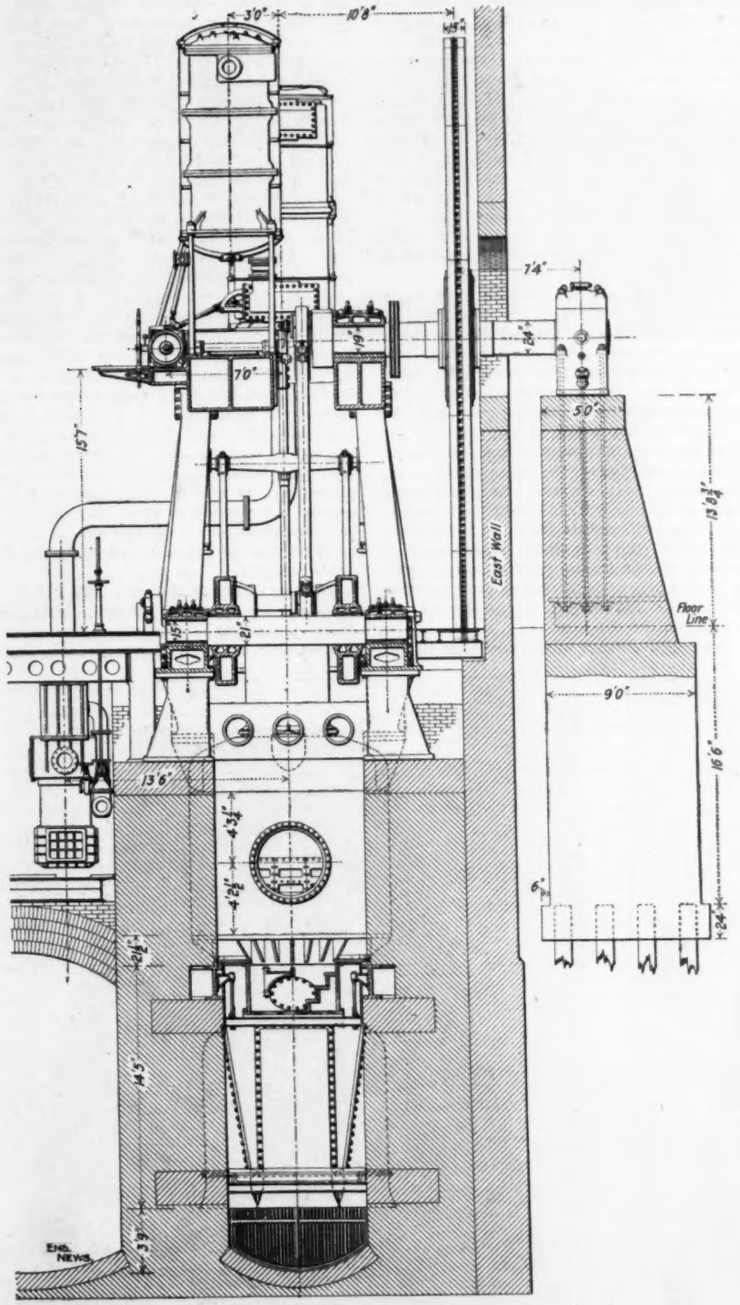


FIG. 2. TRANSVERSE SECTION.

namely: four pieces forming a conical suction box to which the suction valve seats are bolted; four suction tubes leading to the suction box; one suction chamber, to which the suction box is bolted; one conical delivery chamber, to which the delivery valve seats are bolted; and a delivery casing made in two parts, containing also the air chambers, as already noted. Structurally, the delivery chamber is the support of the entire pump. It is itself carried in two ways, being hung to the main engine base-plate by cast iron brackets, and supported on cast iron girder frame in the foundation-masonry by twelve adjustable jack-screws, arranged in four groups, as may be seen at the right hand in Fig. 2. A detail sketch of one of these jack-screws is shown in Fig. 4.

The valves in both suction and discharge boxes are arranged in groups extending in the direction of an element of the cone. The valves themselves are rubber flap valves backed and faced with composition and weighted with lead. They are rectangular in general shape, with longest dimension horizontal. The ports, whose faces are inclined to the horizontal at an angle of about 45°, are 4 ins. wide, by from 16¾ to 20 13-16 ins. long. Each pump has 64 suction valves, each 67 sq. in. in port area, giving a total suction port area, for both pumps, of 8,576 sq. ins. or 59.55 sq. ft.; and 48 delivery valves, of 75.16 sq. ins. average port area, giving a total delivery area, for both pumps, of 7,215 sq. ins., or 50.11 sq. ft. From Fig. 5, a vertical section through a suction valve, the construction and arrangement of valve, seat and guard may be understood.

The 60-in. plungers of the pump work in packing sleeves 6 ft. 2 ins. long, one of which is shown separate in Fig 3. The sleeve is lined with composition in which are turned grooves, as shown. A gland at the upper end of the sleeve affords provision for flexible packing.

The main weight of the engine is carried on a hollow rectangular cast iron base frame extending at right angles to the main shaft. The engine columns rise directly from this frame. A short cross frame, with two heavy footings, gives extra support at the middle where the walking-beam shaft is carried. Cast iron galleries with stairs and handrails are provided for reaching all parts of the engine, but these have been omitted in our Figs. 1 and 2, for the sake of clearness.

The working steam pressure is 185 lbs. per sq. in., above atmosphere. The normal speed of the engine is about 17 r. p. m., at which speed the plunger displacement is 72,000,000 U. S. gallons in 24 hours. The static head on the pumps, from suction well to equalizing reservoir, is ordinarily about 37 ft., but may at times be as high as 43 ft. The dynamic head is, of course, slightly greater. The leading dimensions of the engine are as follows:

Steam cylinders (3, triple-expansion)
HP. 15½ ins., I. P. 33 ins., L. P. 52¾ ins. by 120 ins. stroke.
Pump plungers (2, single-acting) 60 ins. by 120 ins. stroke
Piston rods: HP. and I. P., diameter ..... 4½ ins.
L. P., diameter ..... 5½ "
Pump rods, diameter ..... 6 "
Links, 10 ft. long, c. to c.; diam. at neck ..... 4½ "
Pins at crosshead and beam ends ..... 7½ x 7½ "
Beam pin ..... 10 x 13½ "
Connecting rod, 16 ft. 8 ins. c. to c.; diam at neck. 7½ "
Crank pin ..... 12 x 13½ "
Beam: Radius to link pins ..... 8 ft. 6 "
Radius to conn. rod pin ..... 5 ft. 8 "
Beam shaft, body 21 ins. diam.; journals.. 15 x 30 "
Crank shaft, body, 24 ins. diam.; journals.. 19 x 38 "
Crank, radius ..... 40 "
large eye, ext. diam., 30½ ins., bore.... 22½ "
small eye, ext. diam., 24 ins., bore .... 12 "
thickness of web ..... 14⅜ "
Flywheel ..... 15 x 15 ins. x 36 ft. diam.
hub, 30 ins. long, bore ..... 24 9/16 ins.
weight, about ..... 56 tons.
Valves: gridiron slide,
Travel, HP. inlet ..... 1¼ ins.
HP. exhaust ..... 1 in.
I. P. and L. P. inlet ..... 1 11/16 ins.
I. P. and L. P. exhaust ..... 1 9/16 "
Ports: HP., width ..... ⅛ in.
I. P. and L. P., width ..... 1 "
Cams: inlet and cut-off, throw ..... 1¼ ins.
exhaust, throw ..... ⅜ in.
Steam pipes: inlet nozzle..... 5 ins.
HP. exhaust ..... 6 "
I. P. inlet ..... 8 "
I. P. exhaust ..... 10 "
L. P. inlet ..... 12¾ "
L. P. exhaust ..... 15 "
Air pump: Vertical single-acting bucket pump, 35 ins. bore x 24 ins. stroke.
Bed plates (assembled), length, over all ..... 42 ft.
Width, over all .... 16 ft. 3 ins.
Pump, suction chambers (ext. dimensions):
Bottom ..... 5 ft. 5⅛ ins. x 6 ft. 5¼ ins. oval.
Top ..... 8 ft. 2 ins. x 9 ft. 2 ins. oval.
Height..... 13 ft. 2¾ ins.
Delivery casings:
Diameter (ext.) ..... 12 ft.
Height .... 10 ft. 2⅝ ins.
Suction valves (128 in both pumps) .... 4 ins. x 16¼ ins.
Delivery valves (96 both pumps) 4 ins. x 16¼ to 20 12/16 ins.

The Calf Pasture pumping station is part of the Main Drainage Works forming part of the Sewer Division of the Street Department, City of Boston. Mr. E. S. Dorr is Chief Engineer of the Sewer Division, and Mr. H. W. Sanborn is Executive Engineer of the Main Drainage Works. We are indebted to these gentlemen, in particular to Mr. Sanborn, for the material from which our text and illustrations were prepared.

THE HART CONVERTIBLE BALLASTING AND FREIGHT CAR, AND THE WORK OF BALLASTING TRACK.

In the extensive work of ballasting new and old tracks considerable use is being made of the Hart convertible dump car, which is an improved form of the Rodger ballast car that has been in use for several years. The Rodger car was of the center-dump type, the bottom forming a long hopper between the trucks, so as to deliver the material between the rails, while a spreader or plow under a car at the rear of the train threw the excess amount of ballast to the outside of the rails. The Hart convertible car can be used either (1) as a center dump car, or (2) as a side-dump car with swinging doors and no end gates, being used in this way for ballasting, filling trestles, track elevation, etc., and being unloaded by a plow hauled through the train of cars. A special feature of the convertible character is that the car can also be used (3) either as a dump car or an ordinary gondola in general freight service when not required by the roadway department. When used for cases (1) and (3) there are end gates fitted; but for use in case (2) the ends are removed, and iron aprons hinged to the tops of the end sills are let down to cover the open spaces between the cars, thus affording a path for the unloading plow and preventing the ballast from falling upon and between the rails. When used

in freight traffic, this type of car is very convenient for the transportation of coal or other dumpable material going in one direction and returning loaded with lumber or other merchandise, thus giving continual service and reducing the empty mileage haul to the minimum. The cars are built by the Rodger Ballast Car Co., Railway Exchange Building, Chicago.

The variable arrangements above described are shown in Fig. 1, which gives two end views of one of the new cars. Fig. 2 is a side view of one of a number of cars of this type, with steel underframes, used for hauling coal to the St. Louis Exhibition last year, and this has sides raised by extra planks to increase the capacity to 82 cu. yds., with load heaped up. When in use for ballasting or construction work, the top boards are removed, and the top of the car is the heavy belt rail above the doors, as this is more convenient for loading with steam shovels. The capacity of the car, arranged for center dumping, is then 41 cu. yds. level full, or 53 cu. yds. with load heaped up at an angle of 15°. The cubic capacity is slightly greater when used as a flat-floor car. The dimensions of the car shown in Fig. 3, are as follows:

Length over end sills	41 ft. 0 ins.
Length inside	39 " 0 "
Width inside	8 " 8 "
Height from rail to top (without side boards)	7 "11 "
Height of side above floor (" " ")	3 " 6 "
Wheelbase, total	38 " 2 "
Wheelbase, truck	5 " 6 "
Load limit	110,000 lbs.
Capacity	100,000 "
Weight	43,700 "

It will be seen that the car has a fixed hopper, with sloping sides extended above the floor by doors which are hinged at the edge of the hopper and fold back against the fixed sides of the car. To convert the car into a gondola, these doors are closed down, resting upon cross pieces. For plowing or shoveling gravel, ballast, etc., out of the sides of the car, the sides are formed by doors which are hinged to the belt rail and swing outward, being normally held closed by locks on side shafts running along the sills. The drawing in Fig. 3 shows some of the construction features of the car. The time required to convert these cars from the hopper type to a gondola (or vice versa) has been greatly reduced by the elimination of all loose parts and doing away entirely with the removable center sill and convertible floor rests. Four men can now make the change in 10 minutes. At the same time the convertible doors are so constructed and supported as to prevent any material from getting behind and dislodging them, as sometimes occurred in the original construction when cars were used for ballasting purposes. In the new arrangement there is no shelving for material to lodge at the point where the hopper doors (when raised) meet the sides of the car, thus presenting a clean surface which facilitates the working of the car. In the earlier cars some difficulty was experienced at times with boulders and (when used in the coal trade) large lumps of coal becoming lodged in the door opening. The new cars have a larger door with a clear opening of 22 ins. for the full length of the hopper, as against 16 ins. on the old cars.

One of the improvements in the new cars is the use of oak side stakes (4 × 7 ins.) which are made the same section throughout their entire length. The earlier cars had the stakes gained out 2 ins. from the top of the sill to the bottom, making the stake only 4 × 5 ins. at this point. This new construction greatly increases the strength of the stakes, and to compensate for the increased width, the width of the underframe is reduced from 9 ft. to 8 ft. 8 ins. over the sills. A malleable iron bearing, A, (in the cross section, Fig. 4) is placed on the outside of the stake, extending upward to a point 10 ins. above the floor, and a U-bolt, B, is passed around this bearing and the stake and secured to the intermediate sill, thus holding the stake at the highest point possible so as to prevent the sides from bulging. On the inside of the stake is fitted a ½-in. steel channel rubbing plate, C, 10 ins. high; this takes the wear of the unloading plow, preventing the stake from being broken off at the sill line, the strain of the unloading plow being the most severe to which the stakes are subjected. A new cam lock, D, (in the side elevation, Fig. 3) supersedes the old method of locking the side shafts with link and pin. The latter arrangement on the old cars was placed at the end of the shaft, and experience showed a tendency to twist the shaft. The new cam device is placed on the side of every second or third door of the car, and locks the shaft and doors securely.

Another detail of the new cars is a ratchet escapement for operating the drop doors for center-dump ballasting. This takes the place of the ratchet dog or latch formerly used, and enables

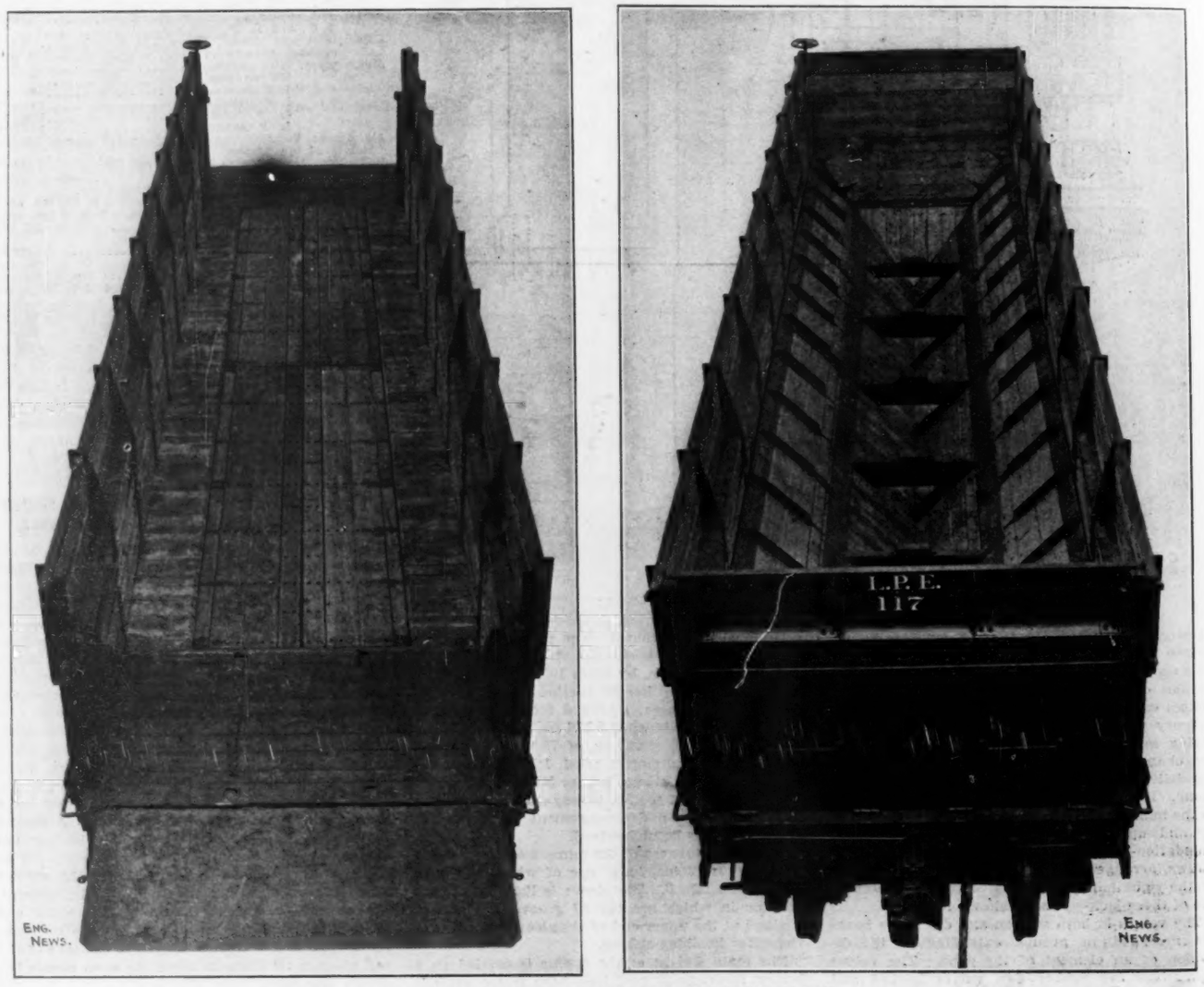


FIG. 1. THE HART CONVERTIBLE BALLAST AND FREIGHT CAR.
Rodgers Ballast Car Co., Chicago; Builders.

FIG. 2. HART STEEL-FRAME DUMP CAR FOR HANDLING COAL.

one man to control the door, each notch of the escapement letting the door open about an inch. This is shown in the end elevation in Fig. 3. The escapement, E, has always one end engaged with the toothed wheel, F, on the operating shaft, and is moved by a lever, G, formed in one piece with the escapement. The lever is normally held or locked by a pivoted cam, H. With cars having this device a ballast train can be sent out in charge of a conductor and two brakemen. The conductor operates the cars and directs the movement of the train; one brakeman stands on the plow car at the rear of the train to raise the plow to clear crossings, frogs, switches or other obstructions; the other brakeman acts as flagman. It is stated that with such cars, and under ordinary conditions this crew can unload and distribute one run of ballast at the rate of 30 cu. yds. per minute. This one train load will suffice to raise the track 4 or 5 ins. If a greater raise is required, a second or third run is made over the same piece of track, thereby placing a greater amount of ballast on the ends of the ties. The plow has an adjustable flange, which can be arranged to distribute the ballast further from the rail if desired.

BALLASTING TRACK.

When the ballast is distributed in the center of the track, and a certain amount is plowed to the outside of the rails, in the way above described, the work required to put the ballast under the ties is reduced to a minimum, as it is only necessary to jack up the track and tamp the ballast under the ties. This saves the time and cost of one handling of the ballast, as compared with the method of depositing the ballast at the sides of the track, and then shoveling it into the space between the rails. To put 12 ins. of ballast under the ties requires about 3,000 cu. yds. per mile, and when this is placed on the side of the track, practically all of it has to be rehandled in working it to the center. If one man can shovel about 20 yds. of ballast per day, it would require 150 men one day to handle 3,000 cu. yds. of ballast, and with labor at $1.50 per day, the work would cost $225 per mile. On the Chicago & Eastern Illinois Ry., the method used for this class of work was first to make a run over the new track with a train of center-dump cars and then a second run of side-dump cars with plow, piling as much material as possible in the center and on one side of the track. The same cars were used for both kinds of service. Sticky material, such as clay, will not discharge from any kind of hopper car, and for this class of service the plow drawn by a Lidgerwood rapid unloader gives the best results.

The Delaware & Hudson Ry. last year purchased 50 of these cars for ballasting with broken stone, but the work has only recently been commenced. The loaded cars are sent in freight trains, set off at the nearest point to the work, and then taken out by construction engines and dumped on the track. They are used as center-dump cars, the material being distributed to the outside by a spreader, and the average speed of the train while dumping is about three miles an hour. The depth of ballast deposited with one car load is about 4 ins. On the Chicago, Rock Island & Pacific Ry. all ballasting for the past few years has been done with the Rodger dump cars, dumping in the middle of the track; they handle stone, gravel, burned clay and disintegrated granite. There are from 15 to 25 cars in a train, with an average of 25 cu. yds. per car, and the average speed of the train while dumping is about four miles an hour. The depth of ballast under the ties that will be made with one unloading varies according to conditions; when the track is stripped and the ballast is of such a character that it will run freely, enough can be dumped with one unloading to raise the track 6 ins.

We have been able to obtain some interesting figures as to ballasting with different types of cars. On the Delaware & Hudson Ry., four men are employed to operate a train of dump cars; while with a train of 20 flat cars and a plow operated by a Lidgerwood rapid-unloader there are three men, one to operate the plow engine and two to take care of the snatch blocks and cable. With the latter trains, as many as 100 cars, with 10 cu. yds. per car, have been handled in a day, but no comparative figures can be given for the dump cars, as it has been impossible to get material from the crusher fast enough to keep the men working continually. The cost per cubic yard of ballast deposited is somewhat cheaper with the dump cars and spreader if the ballast is broken stone, and for this material the dump cars are much preferred. With gravel ballast, however, the use of flat cars with side boards and a side plow operated by a rapid-unloader is considered to be the cheapest and quickest method of unloading.

On the Chicago, Rock Island & Pacific Ry. the crew of a ballast train (exclusive of the men on the engine) usually consists of a conductor and two or three brakemen; there are no section men or extra gang men on the train. The number of cubic yards of ballast deposited and put under the track per working day varies according to the size of the gang on the track. Assuming that there will be power enough and cars enough to haul all the ballast that a gang (large or small) can put under the track, the difference in cost between ballasting with Rodger dump cars and with flat cars and a plow is from $60 to $75 per mile with stone ballast; with gravel ballast the difference will be somewhat less. The cost of ballasting varies with either style of car, being higher for stone than for gravel, and depending also on the material, the amount of material used, and the length of haul. Ballast is now being used which costs in some cases 5 and 6 cts. per cu. yd., loaded on the cars, while in other cases the material costs 30, 35 and even 50 cts. per cu. yd. It is therefore impossible to give an average cost for ballasting. The Rodgers cars can be used for center or side dumping, but in ballasting they are always used as center-dump cars, since this arrangement places the ballast more nearly where it is used, namely in the center of the track, and about to the end of the ties outside the rail. The side dump discharges all of the ballast material outside of the rail, the same as a flat car, and all of the material unloaded from side-dump cars or flat cars that is required between the rails has to be shoveled by hand to get it in place. It is on the cost of doing this shoveling

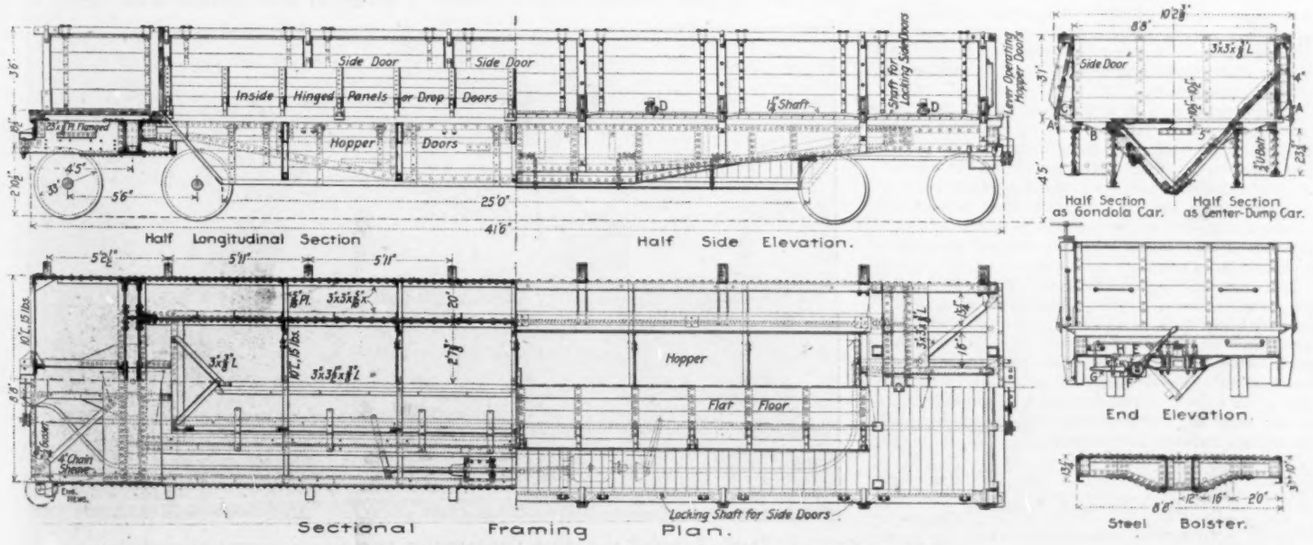


FIG. 3. THE HART CONVERTIBLE BALLAST AND FREIGHT CAR.
Rodger Ballast Car Co., Chicago; Builders.

that the above estimated saving of $60 to $75 per mile was given. The center-dump cars also have another advantage over flat cars in ballasting; this is that they unload themselves when the gates are open, while the material on a flat car has to be plowed off, either by a Lidgerwood unloader or by using power direct from a locomotive to pull the plow.

On the Louisville & Nashville Ry. ballasting with blast furnace slag has been done with hopper-bottom dump cars built in the company's shops; these dumped the material in the center of the track, and it was spread by a cross tie or plow on top of the rails and in front of the wheels of the car, so that each car deposited ballast to the height of the top of the rail. The trains averaged about 15 cars each, with 22½ cu. yds. per car, and the crew consisted of a foreman and six shovelers in addition to the regular train crew. About 30 cars per day were handled, and the cost is estimated at 45 cts. per cu. yd. deposited, including loading and train service.

A LONG DISTANCE ELECTRIC POWER TRANSMISSION LINE IN NEVADA.

By E. Prince.*

The Nevada Power, Mining & Milling Co. was organized late in 1904 to develop the power of Bishop Creek, in Inyo County, California, and deliver it by electric transmission to the Goldfield and Tonopah districts of Nevada and the interlying towns and mining districts.

As late as September, 1903, a half dozen prospectors' tents sheltered the population of the present Goldfield mining district. The population today is not less than 6,000. Transportation facilities have been hopelessly inadequate. Recently a hundred thousand dollars' worth of freight was lying exposed to the weather at Tonopah for want of teams to haul it to Goldfield. A thousand narrow gage cars were awaiting movement from Reno to Tonopah. The Southern Pacific Company notified shippers that "no more freight for Goldfield except food supplies would be accepted until the present blockade is cleared." The narrow gage line is now being made standard gage and its extension to Goldfield has been decided upon. In less than a year Goldfield has reached a prominence not attained in so short a time by any other mining camp in history. This unprecedented growth is due to the richness of the ore bodies at Tonopah and Goldfield and in that section of the country.

Outcroppings over approximately 35 square miles of territory indicate the mineralization of the entire district, and have satisfied the most conservative mining authorities that developments to this time are but promise of much greater things to come. To develop these large ore reserves will call for permanent power plants at the mines and mills, sampling works, etc., demanding large amounts of power.

The Company has secured by appropriation and purchase exclusive rights to the water of Bishop Creek at the only point of the stream where a large amount of power can be developed within permissible cost. Reliable data as to measurements show the minimum flow of stream to be 34 cu. ft. per second. The maximum flow is 500 cu. ft. per second. The following data are from the Company's surveys and estimates:

Length of flow line	6,700 ft.
Length of pressure pipe	5,333 ft.
Hydrostatic head	1,064 ft.
30 Sec. ft. of water under 1,024 ft. effective will give	3,466 HP.
Efficiency of water wheels 80%, power delivered to generators	2,772 HP.
Efficiency of generators 94%, delivered to transformers	2,605 HP.
Efficiency of step-up transformers 97%, delivered to line	2,526 HP.
Efficiency of line, No. 0, aluminum wire, 90%, delivered to step-down transformers	2,273 HP.
Efficiency of step-down transformers 97%, delivered to distributing system	2,205 HP.
Efficiency of distributing system 95%, delivered to customer	2,095 HP.
Without overload combined efficiency of system	80.4%
Add 25% for overload	523 HP.
	2,618 HP.

From the power house the electric transmission line will run in almost a direct course to Goldfield and Tonopah, a distance to the former by the route taken by the pole line will be 90 miles, and the branch to Tonopah will make a total of 120 miles.

The estimated cost of construction is $350,000, which will probably be further increased by the purchase of existing electric light plants in Tonopah and Goldfield. The work has progressed sufficiently far that the company has announced that the line will be completed and power ready for delivery in Tonopah and Goldfield by September, 1905.

The organization of the Company consists of directors: Lawrence C. Phipps, F. J. Campbell, G. S. Wood, Rodney Curtis, C. M. Hobbs, Thos. B. Rickey and Edward Prince, with F. J. Campbell, President; Rodney Curtis, Vice-President; G. S. Wood, Secretary and Treasurer; C. F. Potter, Attorney; C. M. Hobbs, General Manager; C. O. Poole, Consulting Engineer; and Mr. Galloway, Engineer.

The physical features may be described as a diverting dam on Bishop Creek in Inyo County, California, from which the water estimated at 30 cu. ft. per sec. flows into 6,700 feet of 42-in. wood pipe, thence into 2,210 feet of 30-in. wood pipe, thence into 3,240 ft. of 24-in. steel pipe to the power house, in which are contained two 750 KW. generators, with exciters, transformers, switch board, high tension switch, lightning protectors, etc. etc. The three-phase alternating current is conducted at 60,000 volts on aluminum cables across the White Mountains, and thence on to a sub-station, one pole line then leading to Goldfield and the other to Tonopah, at both of which places will be transformer stations, from which will be delivered the electric energy to the electric light stations, reduction works and customers generally at probably 15,000 volts. The Nevada Power, Mining & Milling Company owns the majority of the stock in these electric light plants of both these towns, each of which has a population at the present time of about 6,000. The water wheels for the two units, exciters, etc., are to be furnished by the Pelton Wheel Company. The 24-in. steel pipe is 5-16 in., ¼ in. and ½ in. in thickness, lap-welded and is made up in 30-ft. lengths. The pipe is made in Germany and shipped to New York, thence to Reno, Nevada, thence south to Laws Station, thence hauled twelve miles to the power house. The fall obtainable is 1,074 ft. It is believed the Company will be able to deliver without too much of an overload 2,500 HP. in Tonopah and Goldfield.

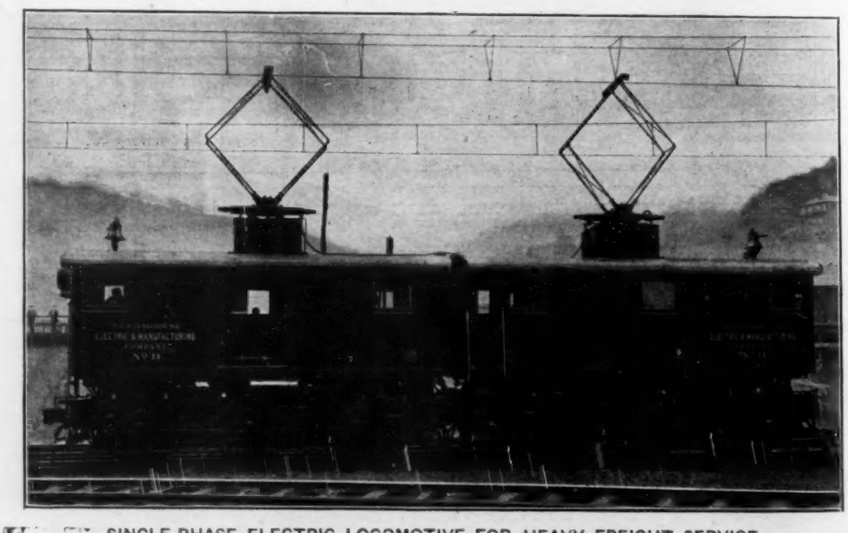
At the present time, June, 1905, most of the pipe line is completed, the power house is well under way and the pole line is approaching completion, and all the heaviest and most important material for the completion of the works is either on the ground or en route from the factories.

*Civil Engineer, Quincy, Ill.

A POWERFUL SINGLE-PHASE ELECTRIC LOCOMOTIVE FOR FREIGHT SERVICE.

The electric locomotive shown in the accompanying cut is the first alternating-current machine built for heavy railway service in this country, and it is designed for the highest trolley wire voltage ever used in this country. In addition to this, several special features are claimed: (1) It is the largest alternating-current locomotive in the world and also the largest to be operated by single-phase curren; (2) it is the largest ever operated on the trolley system; (3) it is equipped with six of the largest single-phase motors ever built, and is the first to have forced ventilation of the motors. It was built by the Westinghouse Electric & Mfg. Co., as an exhibition or experimental machine and has hauled a train of 50 steel gondola cars, representing a total weight of about 1,200 tons. It is intended for slow freight traffic, and with the motors working at nominal full load output, it will develop a drawbar pull of 50,000 lbs. at 10 miles an hour; with test train noted above steady pulls of 60,000 to 65,000 lbs. were recorded by dynamometer; momentary efforts as high as 100,000 lbs. have been obtained without slipping the wheels. With lower loads, locomotive can run to a maximum speed of 30 miles an hour.

The locomotive consists essentially of two separate machines, coupled together, but is intended for use as a single machine. It is 45 ft. long and 9 ft. 8 ins. wide, with a height of 17 ft. above the rails when the trolleys are lowered. The side frames are of cast steel. Each half of the locomotive forms a six-wheel truck with wheels 60 ins. diameter and a wheelbase of 12 ft. 8 ins., the total wheelbase of the engine being 38 ft. The axles are 8 ins. diameter and the weight on the two inside axles of each truck is equalized. The total weight is 135 tons. On each axle is a 225-HP. single-phase, series, single-reduction geared motor; one side of this is carried by the axle and the other is suspended by spiral springs from the framing. The three motors on each truck are connected permanently in parallel and controlled by an induction regulator, which varies the voltage from 140 to 323 volts at the motor. These regulators are driven by small series motors and are controlled by the multiple unit system from a master switch at each end of the engine. Motor driven compressors are used for the brake system, and motor driven blowers for ventilating the motors, auto-transformers and induction regulators. The machine is designed for a current of 25 cycles and 6,600 volts on the trolley wire, the current being taken by a flexible jointed frame and trolley bow instead of the usual rod and contact wheel. The trolleys are raised and lowered by pneumatic cylinders controlled from the cab. The current passes through an oil switch and circuit-breaker to an auto-transformer in each cab.



SINGLE-PHASE ELECTRIC LOCOMOTIVE FOR HEAVY FREIGHT SERVICE.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa., Builders.

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Entered at the New York Post-Office as Second-Class Matter.

The engineering profession has received with great regret the news of the resignation by Mr. John F. Wallace of the Chief Engineership of the Panama Canal Commission. Mr. Wallace's reputation in the profession is such that engineers have felt confident that good and thorough work and able and honest business management were guaranteed by his position in responsible charge of the work in the field.

That his resignation occurred in such a manner as that recorded in this issue is likewise cause for profound regret. Engineers will agree that a member of the profession placed in responsible charge of an enterprise ought to so arrange his withdrawal, if withdrawal becomes necessary, that the enterprise and its officers shall suffer the least possible loss or inconvenience. This is true of any position and it is particularly true of an official position under the government. It goes without saying that no man should accept either an elective or an appointive office without the deliberate decision to discharge its duties for a reasonable time at least.

It is a pity that Mr. Wallace decided to relinquish the work so soon after accepting his new position as a member of the commission, with enlarged powers and responsibilities; yet it is fair to believe that he did desire and intend so to arrange his withdrawal as to cause little inconvenience to the government and no delay to the enterprise.

That there will be, in fact, no delay to the work and that it will go forward successfully with others in charge, there is every reason to believe.

Secretary Taft's vexation, under all the circumstances, was natural enough; but it seems to have led him to overstate the effect Mr. Wallace's withdrawal was likely to have. On this matter, Mr. Wallace's statement seems to an engineer much more reasonable than Secretary Taft's. Mr. Wallace left the work on the Isthmus in charge of his principal assistant, a perfectly competent constructing engineer, who can carry on the work without difficulty until such time as the new chief engineer, Mr. Stevens, can take charge.

As for the general plan of the canal, that is a matter for the newly appointed Advisory Board of Engineers to determine, and they will not need Mr. Wallace's assistance in any way, but will go for their information to the records of the work done by the force of engineers which has been working under Mr. Wallace's direction.

The general public is prone to greatly exaggerate the importance to any such work of its Chief Engineer. The fact is that any great engineering work is the fruit of the united efforts of a large body of engineers. Able leadership is indeed essential; but there are many men competent to serve as leaders, far more in number than is usually believed.

It is evident from Mr. Wallace's statement that personal and family reasons have for a considerable time past been urging him toward resignation, wholly apart from the matter of any other business opportunity. When to these considerations was added the proffer of an exceedingly attractive position elsewhere, the final motive for a decision was furnished.

The most unfortunate feature of the whole affair is that Mr. Wallace's resignation has set on foot dozens of absurd stories regarding the Panama work, which are calculated to mislead the public as to the whole Panama enterprise. The old bugaboo that the transcontinental railways are leagued together to defeat an Isthmian canal has again been on parade. The recent offer of a new position to Mr. Wallace became in the imagination of some newspaper reporter the first move in an organized plan to buy off all the competent engineers at impossible salaries as fast as they entered the government service.

Such stories betray their absurdity on their face. The government can get all the competent engineers it needs to build the Panama Canal. There are no difficulties there but what American engineering ingenuity and skill can overcome; and the very able and distinguished Board of Consulting Engineers, whose appointment was announced last week, is as competent a body to solve the important engineering problems presented, as could have been selected.

An excellent illustration of the need of some international organization or congress of nations with a view to protect the general interests of all countries in safe transportation on the high seas is furnished by the announcement that a British Columbia company proposes to tow a large log raft, containing 10,000,000 ft. B. M. of logs and spars, across the Pacific to Shanghai, China, this summer. It is admitted that any such raft runs a large risk of going to pieces should it meet a severe storm in its passage across the Pacific; but the profit through the saving in freight charges is so great that the company is willing to take this risk.

This may be all right from the company's standpoint, but it ignores entirely the risk to shipping which would result from the dispersal of a great mass of drifting logs in the Pacific Ocean. There is good reason to believe that a considerable portion of the unexplained losses at sea—those mysterious cases where a vessel starts out on a voyage and never reaches port, and no record is ever found of what befell her—are due to collisions with derelicts or floating wreckage.

Doubtless we shall soon reach a time when, for the safety of ocean going travel and traffic, international action will be taken for the systematic destruction of derelicts and for the enactment of laws and rules to prevent the abandonment of vessels without taking measures for their sinking. Until such international measures are taken, however, it should be—and we believe is—within the power of any nation to prevent its own citizens from sending out on the high seas vessels or other floating structures which are not sound and seaworthy, and which are therefore likely to become a menace to navigation.

The damage to street pavements, the interruptions to street traffic and the annoyance and loss to shop or storekeepers caused by tearing up streets to make pipe and wire repairs and connections have often been commented on in these columns and made an argument for the provision of subways or galleries for pipes and wires. It appears from our London contemporary, "The Public Health Engineer," that conditions in the British metropolis have become so bad that a conference to discuss the evil of street breaking was held not long ago. Twenty of the London boroughs and the city of London sent delegates to the conference, at which the following resolution was passed:

> That in view of the obstruction to traffic, inconvenience to the public, and serious damage to street paving works caused by the constant interference with the public streets by the Postmaster-General, the electric light and other companies, this conference is of opinion that greater power and control should be given to the highway authorities with regard to the opening of public streets for the purposes of gas, water, hydraulic, electric, telephonic, telegraphic, tramway and similar undertakings, and that a bill should be introduced into Parliament by His Majesty's Government embodying model clauses for the better protection of the local authorities, as representing the traders and public generally, which shall be made applicable to all undertakings involving interference with the public streets.

The Postmaster-General, we may explain, opens the streets to install or get access to telegraph and telephone wires. In Westminster, our contemporary says, no less than 13 companies claim Parliamentary rights to open streets at their own convenience, and they "are not liable for the full cost of the damage done to the roadways." In newer streets, like Shaftesbury Ave., Charing Cross Road, and the Thames Embankment, subways were provided during the construction of the streets, and the same is being done in the case of Kingsway and Aldwich, now being built. Our contemporary states that "not a few experts" consider that to build subways in old streets would be "impracticable from both the financial and the engineering points of view." This is the opinion of many in this country, expert and otherwise, but we believe the time will soon come, if it has not arrived, when in our largest cities it will pay to install subways in some of the most crowded of the old business streets. As to the wisdom of installing subways in new streets, streets being widened or being torn up for underground railways, few will question, aside from short-sighted private corporations whose pipes or wires would be forced into the subways.

The article on the construction of the Kentucky River bridge, by Mr. J. H. Springer, in our issue of March 23, 1905, and the biography of Mr. Bouscaren in our issue of Nov. 17, 1904, each contained statements in regard to this bridge which have been taken to imply that the late L. F. G. Bouscaren was the originator of the idea of cutting the lower chords of a continuous-girder bridge. In the interests of historical accuracy, we have obtained from Mr. C. L. Strobel, M. Am. Soc. C. E., who was Mr. Bouscaren's assistant at the time of the construction of the bridge, a statement of the facts. In the first competition, Mr. C. Shaler Smith (who afterwards built the bridge) submitted a design for a five-span continuous girder bridge. Mr. Pfeiffer, the engineer who made the calculations for the Eads Bridge at St. Louis, then of the firm of Flad & Pfeiffer, had submitted a design in competition for the contract, offering a continuous-girder bridge with the chords cut to, following the plan adopted by the German engineer Gerber, who built a 124-ft. cantilever span at Hassfurt in 1867 nine years earlier. The calculation of stresses for Mr. Shaler Smith's five-span continuous-girder bridge was assigned to Mr. C. L. Strobel, then Mr. Bouscaren's assistant. Mr. Strobel found the stresses in trusses caused by the temperature variations in the height of towers to be very great, and no allowance had been made for these stresses. Furthermore, Mr. Smith's calculations had been based upon arbitrary assumptions for the position of the points of contraflexure, which did not give correct results. At this stage it was decided by Mr. T. D. Lovett, the Chief Engineer, that the bridge would have to be built with only two piers, making it a three-span bridge. The suggestion was then made to Mr. Smith, probably by Mr. Bouscaren, that he could avoid the large increase in cost involved in adhering to his original design, by cutting the chords. In this way the temperature variations in the height of towers would not affect the stresses in trusses and the points of contraflexure would be mechanically fixed in position. These features were thereupon adopted by Mr. Smith, and a final stress sheet was prepared and submitted embodying them. Satisfactory modification in price having been made, the contract was left to Mr. Smith on this basis.

It may also be noted that Mr. Bouscaren was not Chief Engineer when the bridge was built, as was stated in Mr. Springer's article. Mr. T. D. Lovett was Chief Engineer, and Mr. Bouscaren was Principal Assistant Engineer.

For a more extended review of early cantilever

bridge construction, reference may be made to an editorial note published in our issue of Nov. 24, 1904.

SAFEGUARDING RAILWAY SWITCHES.

We alluded last week to the abolition of facing point switches on double-track railways as one lesson of the disastrous wreck at Mentor, O. It has been publicly announced since then that official orders have been issued to change all switches on the main line of the Lake Shore & Michigan Southern Ry. to trailing switches. We presume this does not mean actually all, for there are doubtless places where such a change would be a very serious expense and inconvenience; and in large yards, where turn-outs from the main line are numerous, speed ought to be reduced anyway, so that facing point switches there would not be so objectionable.

As was naturally to be expected, the Mentor wreck has drawn general attention to the subject of safer switches and much discussion is going on in the public press as to how switches may best be protected.

One authority lays down the rule that all switches should have a distant signal connected with the switch-stand, which should be moved automatically in harmony with the movement of the switch-stand target. This plan may look well on paper; but in our opinion it would lead to greater dangers even than those which it proposes to avoid.

We have for years strongly advocated the greater use of distant signals, in connection with block signaling installations and with such work as the protection of railway grade-crossings or drawbridges; but the proposal to attach distant signals to switch-stands appears to be a serious mistake. The distant signal is a proper device for use in connection with a home signal which is at any time likely to stand at danger; it is highly improper for use with such a home signal as a switch-stand target, which the engine-runner always expects to find at safety.

A distant signal, of course, merely repeats the indications of the home signal; it gives the engine-runner warning of the position of the home signal far enough in advance to enable him to stop before reaching it. But in all ordinary weathers and with trains running at ordinary speeds, an engine-runner can read the home signal so far back that he can stop anyway before reaching it and the distant signal is not needed at all.

What we do need it for is the high-speed trains. These high-speed trains, however, are never supposed to run against open switches. The engine-runner of such a train when at full speed always approaches a switch expecting to find it closed, as it always is unless some one has blundered. Not once in perhaps a hundred thousand times does the engine-runner of a train at full speed find a switch open on the track ahead. In the rare cases where a switch is found open, if the switch-stand has a proper target, the engine-runner can and almost invariably does discover it far enough back to stop or materially check the speed of his train before he reaches the switch.

All we would gain by attaching a distant signal to a switch-stand, therefore, would be in the case of the most unusual combination of a misplaced switch, a fast train, and weather conditions preventing the engine-runner from seeing the switch-target until close onto it.

There would, on the other hand, be a distinct loss from the multiplication of signals. Here is a switch-target which stands straight, say every hundred thousand times it is passed.

All we can expect is that an engine-runner will unconsciously note the position of the target as he approaches it. He will not and ought not to give it the same degree of attention that he does the semaphore at the entrance of a block or at a grade-crossing. If now we put up a signal to duplicate the indications of the switch-target say 2,000 ft. back, we are putting up a signal to which engine-runners will pay very little attention. If they find it at danger, they will lay it to derangement of the connections and the chances are that nine times out of ten they will be right. We must also face the possibility that sometime this signal will, through derangement of the connections, stand at safety when the switch ahead is open and will thus actually mislead the engineer. We are strongly of the opinion therefore that money spent to erect and maintain distant signals in connection with switches is worse than wasted. Any signal which is not actually and directly of importance to the engineer to tell him whether the road ahead is safe, is not merely useless, but dangerous. It is a needless strain upon his attention and tends to weaken in some degree the importance and authority of the signals which he ought to read.

What then should be done to safeguard switches? The answer is of course familiar to all our readers who are familiar with good signaling practice. Main-line switches ought to be so connected with the track circuit of the block system that the block signal itself will indicate whether every switch in the block is closed. If any are open, the signal will remain at danger. It may be said that a very small mileage of railways in this country is equipped with track-circuit blocking; but lines which are not so equipped have no business running trains at 60 to 70 miles an hour.

Facing point switches ought to be avoided on double-track lines, as we have already said, not only because of the chance of the switch being misplaced; but because there is undeniably a greater chance of derailment at a switch, even when it is perfectly closed and locked, when a train runs against the points than when it trails over them.

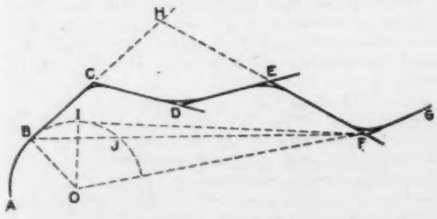
Every main-line switch ought to have a target attached to it sufficiently large and prominent to enable an engine-runner to tell the position the switch is in in clear weather at least 2,000 ft. away on the facing side. The construction of the switch should be such as to ensure tight closing of the points when the switch is locked; and safety-guards in front of the points to protect them from being struck by hanging chains or brake rigging or loose wheels are a desirable addition.

LETTERS TO THE EDITOR.

To Connect Two Curves with a Tangent.

Sir: In picking up a back number of the Engineering News (Feb. 23, 1905) I noticed Mr. Stowell's letter on "A Problem in Railroad Location," and the following very simple solution suggests itself:

Taking Mr. Stowell's illustration, Fig. 1, the point F has been connected with the curve at B by any meander line (in this case B C D E F), and the relation of O to B is also known, hence the latitude and departure of F



with reference to O (as zero) can be computed, and the length and bearing of OF thus obtained; the length of OI (radius) is also known, and the angle OIF being 90° we have the base and hypothenuse of a right angle triangle to find the angle IOF and the perpendicular IF, whence we have $\frac{OI}{OF} = \cos$, angle IOF; and OF × sin IOF=IF. Now having the bearings of the lines BO and OF and the angle IOF, the angle BOI is simply a matter of subtraction and equals the intersection angle at the PI on the tangent BC. Respectfully yours,

Arthur S. Hobby.

Guantanamo, Cuba, June 16, 1905.

Strength of Concrete with Oyster Shell Aggregate.

Sir: I should like to have some information on the relative strength of concrete using oyster shells as the aggregate as compared with concrete using stone. In this locality we have oyster shells in abundance, while the price of stone is comparatively high, and I am of the opinion that considerable work, which is rather costly when using stone concrete, could, with judicious design, be done materially cheaper if shells were employed. Would it not be better in using the common size oyster shells to have them broken instead of using them in their natural shape, which presents too flat a surface?

Along the Florida East Coast Ry., they use, with very satisfactory results, a deposit composed of sand and Coquina shell. The Coquina shell is a very small shell averaging about the size of one's thumb nail. Of course the good reason for using this Coquina shell in Florida is that it is cheap, while stone is expensive. I should appreciate it very much if your readers will give me the benefit of their experience in this matter. Do you know of any cases where shell has been used in reinforced concrete work? Very truly yours,

Wayne Cunningham.

Savannah, Ga., May 30, 1905.

(We submit the inquiry to our readers.—Ed.)

A Method Wanted for Establishing Irrigation Canal Tangents So Cut and Fill Will Balance.

Sir: May I put a difficulty I am encountering before the readers of Engineering News and ask for any assistance that may be available?

I am engaged in locating and constructing an irrigation ditch with a 0.4% grade, and want some general method of establishing the position of the tangents, so that the quantities balance—the cut plus a shrinkage percentage to be equal to the bank.

The method I am using is to run a falling contour line at the grade where the cut makes the bank; straighten this out and run a center ditch and center bank profile, and figure the quantities from the cuts and fills; find the greater of these, say excess bank; divide the difference of these by the number of stations on the tangent for the decreased quantity per station, and subtract this from the tabular quantity for the average fill; find the new fill and compute the amount to "shy" the line from the difference of level of the center and side slots.

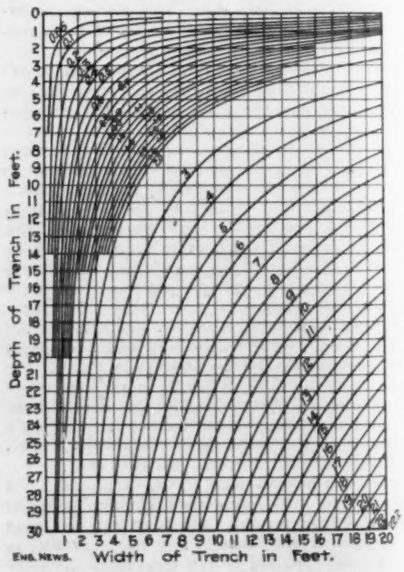
Besides being cumbersome in principle the method has to be eked out by a good deal of guessing on any but the easiest ground. It occurred to me that some graphical method may have been developed to enable the "shy" of the line to be figured more closely. If such is the case, I would be glad if your readers would refer me to some source of information or give me any hints by which the problem might be treated more rationally.

I am, sir, yours truly, Tangent.

Canada, June 22, 1905.

A Diagram for Estimating the Yardage of a Trench.

Sir: I enclose print of a diagram which I have found very convenient in making estimates of amount of excavation in pipe trenches. Although it is possible that such a diagram may have been published before I have never seen one. On rough ground the cubical contents



of a trench may be read from the diagram about as accurately as it could, or would ordinarily, be calculated. It may also be used for approximate estimates of railway cuts and fills by taking the mean width and average depth of the cut or fill.

Yours very truly, J. S. E.

Philadelphia, Pa., June 9, 1905.

JOHN F. STEVENS: THE NEW CHIEF ENGINEER OF THE PANAMA CANAL.

Almost immediately upon the resignation of Mr. John F. Wallace as Chief Engineer of the Panama Canal Commission and the acceptance of his resignation by the President and Secretary of War announcement was made of the appointment of Mr. John F. Stevens of Chicago as his successor. The appointment was tendered Mr. Stevens by telegram on June 29 and he signified his acceptance by telegram on the following morning. The salary of the new Chief Engineer is to be $30,000, which is $5,000 more than that received by Mr. Wallace. This was arranged between the President and Secretary Taft. Mr. Stevens will not be, for a few months at least, a member of the Canal Commission, but will serve as manager of the Panama Railroad. The appointment to fill the vacancy in the commission caused by Mr. Wallace's resignation will not be made until the return of Secretary Taft from the Philippines in October.

In announcing the appointment of Mr. Stevens, the War Department gave out the following statement dated June 30:

Mr. John F. Stevens has been appointed Chief Engineer of the Isthmian Canal, with residence on the isthmus, to take effect at once.

Mr. Stevens is now in the service of the Philippine Commission as government railway expert in the 1,000 miles of Philippine railways about to be constructed under government aid. Mr. Stevens was to have to-day accompanied Secretary Taft to the Philippines, but has been transferred to the Panama Canal.

He was until recently Vice-President and General Manager of the Rock Island system, formerly Chief Engineer and General Manager of the Great Northern Railway, and has had extended experience in the projection, construction, operation and management of large enterprises.

The duties of chief engineer of the Isthmian Canal especially relate to the practical work of construction and operation. The technical plans are to be determined by the commission as a body, with the advisory international board of engineers recently appointed by the President, and whose plans, as decided from stage to stage, will be executed on the isthmus by the chief engineer. With the chief engineer confining himself to the actual work of construction and operation and concentrating upon the execution of the plans as adopted by the commission, it is believed that the canal work will be more actively prosecuted.

While with the Great Northern as engineer of construction, in 1899, Mr. Stevens, with two Indian guides and a pack mule, started from Assiniboine to lay out the western extension of the Great Northern to the Coast. The Indians deserted him and his pack mule died. He persevered in his work and after much hardship completed the task, locating the line as it now runs. Stevens Pass, in the Cascade mountains, was named after him.

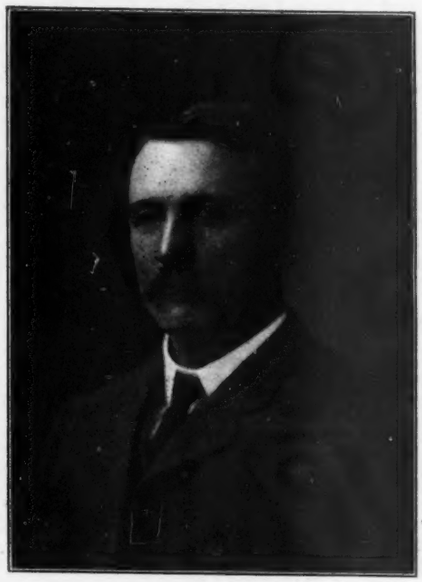
Mr. Wallace is personally acquainted with Mr. Stevens and when the Department was considering the latter's appointment under the Philippine government he wrote a strong letter of commendation, in which he spoke of Mr. Stevens "as one of the best constructing engineers in the country."

Mr. Stevens was born at West Gardiner, Me., in 1853. After being educated in the public schools and in the State Normal School he went to Minnesota in 1874 and was employed that year and the next as assistant in the city engineer's office at Minneapolis. Early in 1876 he went to Texas and for three years was employed on preliminary and location surveys as chief engineer of the proposed Sabine Pass & Northwestern Ry. (afterwards built under other names) between Denison and Sabine Pass. He spent considerable time during this period in the service of other roads in operation.

In the fall of 1879 he went to New Mexico and entered the service of the Denver & Rio Grande R. R. as assistant engineer in charge of heavy mountain location and construction. He remained at his work during a part of 1880, when he went to the Chicago, Milwaukee & St. Paul Ry. and took charge of the location of the main line across Iowa, and of other lines for the same company. He left that company in the spring of 1882 and became the contractors' engineer on the construction of 500 miles of the main line of the Canadian Pacific Railway betweeen Winnipeg and the Rocky Mountains.

During 1883, 1884 and 1885, or until the completion of the road, he was Principal Assistant Engineer of the Canadian Pacific Ry., and was engaged in the location and construction of heavy mountain work across the Rocky, Selkirk and Cascade ranges in British Columbia. In the spring of 1886 he returned to the Chicago, Milwaukee & St. Paul Co. and took charge of the construction of 80 miles of the Ottumwa and Kansas City line, and also of the Sioux City extension of the same system, 90 miles in length. In December, 1886, he went to the Duluth, South Shore & Atlantic Ry., as Principal Assistant Engineer, and took charge of the explorations, location and construction of that Company's line from Sault Ste. Marie to Duluth, remaining until the line was fully completed and turned over to its owner, the Canadian Pacific Ry. Co., in the winter of 1888.

The following year Mr. Stevens was engaged for some months in developing mining property in British Columbia, and the rest of the time was employed as locating engineer of the Spokane Falls & Northern Ry. Co., now owned by the Great Northern. In 1890 he went to the Great Northern Ry. Co. as Principal Assistant Engineer



Yours truly
Jno. F. Stevens

in charge of explorations and surveys of the Pacific extension of this company from Central Montana to Puget Sound. In 1891 and 1892 he held the same position while in charge of the final location and construction of this road across the state of Washington, including the Cascade mountains. On the completion of this line he was made Assistant Chief Engineer of the entire road, with his office at Spokane, Wash. In June, 1895, he was made Chief Engineer of the Great Northern system, with office at St. Paul, and he continued in that position until April, 1898, when for a short time he was engaged in contracting on heavy mountain work on the Canadian Pacific Railway in British Columbia. He returned to the Great Northern Ry. in April, 1899, as Chief Engineer and continued as such until 1902, when he was made General Manager in addition, having charge of all operations.

During his connection with this road as Chief Engineer and General Manager, Mr. Stevens, in addition to taking immediate charge of many hundred miles of construction of new lines, practically rebuilt the most important main lines, with light grades, new alinement and permanent work, the total cost amounting to many millions of dollars. This work included terminals, docks, buildings and various other important operations, including the digging of the Cascade Tunnel, 2.7 miles in length, through the Cascade Mountains beneath the crest of Stevens Pass in the State of Washington.

In 1903 Mr. Stevens went to the Chicago, Rock Island & Pacific Ry. Co. as General Manager and Chief Engineer. Later in 1903 he became Fourth Vice-President as well as Chief Engineer, in charge of operation, maintenance and engineering. In 1904 he became Second Vice-President of the same railway, having charge of the operating, engineering, maintenance of way and purchasing departments. This position he held until May, 1905, when he became railway expert of the Philippine Commission. His appointment as Chief Engineer of the Isthmian Canal dates from July 1, 1905.

Seventeen years ago, or on June 8, 1888, Mr. Stevens became a member of the American Society of Civil Engineers. His appointment to his present position is received with approval by the engineering profession.

THIRTEENTH ANNUAL MEETING OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

The thirteenth annual meeting of The Society for The Promotion of Engineering Education was held at Atlantic City, June 28 and 29, the headquarters of the Society being the Hotel Chalfonte. The Society now numbers nearly 400 members, of whom about 45 were present.

The reports of committees at the first session were for the most part reports of progress; and the President's address was postponed until the evening session, so that an early adjournment was taken.

The first three papers for the afternoon session were as follows: "A Course in Structural Engineering," by Frank H. Constant, Professor of Structural Engineering, University of Minnesota; "Some Points on the Teaching of Mathematics to Engineering Students," by Florian Cajori, Professor of Mathematics and Dean of the Engineering School of Colorado College; "Symposium: Methods of Handling Problem Work in Large Classes," by E. R. Maurer, Professor of Mechanics, University of Wisconsin.

Prof. Cajori and Prof. Maurer showed samples of problem cards used in their respective colleges. An engineering or mathematical problem is stated on the card, often accompanied by a diagram. The card is given to each student who returns it with his solution of the problem. The instructor has another card, numbered to correspond with the problem card, and upon this other card are given the essential feature of the solution of the problem for comparison with the student's solution. By having a large number of problems on cards it is possible not to repeat the same problem oftener than once in two years.

In opening the discussion Mr. Charles S. Howe, President of Case School of Applied Science, said that in handling a class of 90 students he had two assistants, and divided the class into three sections. The first 20 minutes is spent by the whole class in an examination on problems previously given out; then the class is divided into sections, and part of the class goes to an adjoining room filled with blackboards, where problems are solved during the rest of the hour. President Howe believes that in this way better results are secured than by having a class divided into permanent sections under different instructors.

Prof. Mansfield Merriman objected to some of the sample problem cards on the ground that they did not state the problem clearly, and that they told too much in some cases where diagrams were shown. He suggested that students be required to estimate areas of figures before solving problems in areas; for in this way their practical judgment is developed and serious blunders are avoided.

The discussion on the use of problem cards was long but interesting throughout, the consensus of opinion being favorable to the card system, provided that the card does not go so far as to "set the problem," that is, give the student a start.

Following this discussion came three papers on field courses in surveying as follows: "A Field Course in Mine Surveying," by Frederick W. Sperr, Professor of Civil and Mining Engineering, Michigan College of Mines; "Summer Surveying

at the University of Wisconsin," by Leonard S. Smith, Assistant Professor of Topographic Surveying, University of Wisconsin; "Summer Surveying at Cornell University," by Charles L. Crandall, Professor of Railway Engineering, Cornell University.

These papers were very fully discussed, and from the discussions it appeared that a large percentage of the engineering colleges are now devoting part of the summer vacations to field work in surveying. The consensus of opinion of those professors who had tried summer school work was strongly in favor of it. Prof. Henry S. Munroe stated that Columbia University established a summer school of surveying 20 years ago. The original methods of training the students have not been essentially changed. The students are divided into squads of two or three; and each squad is assigned an exercise. Permanent monuments facilitate the checking of leveling, chaining, etc. There are now about 200 students each summer at Morris, Conn., where the school is located.

Prof. Sperr's paper was illustrated by charts showing in detail the time devoted to each exercise in surveying, a total of 12 weeks being given to the subject by every student. The men are divided into small squads, as at Columbia. There are now 72 students under 3 instructors in the surveying course.

The last paper of the afternoon session was, "Opportunities for Engineering Graduates in Government Service," by John F. Hayford, Chief of Division, U. S. Geodetic Survey. The paper gave, in compact form, statistics as to places, salaries, and opportunities for engineers in the various departments of the United States civil service. We shall print the paper in full in a subsequent issue.

At the evening session the following papers were presented: "Organization of a School of Engineering," by Arthur H. Ford, Professor of Electrical Engineering, Georgia School of Technology; "Engineering Instruction in Large Technical Schools," by Henry H. Norris, Assistant Professor of Electrical Engineering, Cornell University; "The Progress and Influence of Technical Education," by Victor C. Alderson, President of the Colorado School of Mines; and "The Design and Equipment of Engineering Buildings," by William G. Raymond, Director of the School of Applied Science, University of Iowa.

In addition to these papers, the president's address by President Fred. W. McNair, President Michigan College of Mines, was given. The address was entitled "American Mining Schools," and had for its object the demonstration that the growth of the numbers of students in mining schools has kept pace with the growth of the mineral industry of the country. The following statistics as to the number of students and graduates in mining engineering were given:

AMERICAN MINING SCHOOLS.

Year.	'89-90.	'90-91.	'91-92.	'92-93.	'93-94.	'94-95.	'95-96.	'96-97.
Students	259	292	346	376	359	414	411	495
Graduates	23	27	33	33	33	74	66	63

Year.	'97-98.	'98-99.	'99-00.	'00-01.	'01-02.	'02-03.	'03-04.
Students	603	630	733	839	972	1,094	1,200
Graduates	78	80	117	129	119	149	175

With the aid of lantern slides President McNair showed that the growth of the mining schools had been even more rapid than the remarkably rapid growth of the mineral industry. In closing, President McNair said:

But whatever may be the defects in individual schools, whether in curricula or the more important methods of instruction, the American mining schools are meeting a real need, and, if we may accept what appears to be the verdict of the mining world, by whose judgment their work must stand or fall, they meet the need in a fairly acceptable way.

The first paper of the morning session of the second day was presented by A. N. Johnson, Highway Engineer, U. S. Dept. of Agriculture, and its title was "Need for Instruction in Highway Engineering." The speaker urged the desirability of giving better instruction in highway economics in our engineering colleges. He believed that as thorough a course in highway work should be given as is now given in railway work. However, he did not favor dropping railway work, nor did he favor crowding present courses, but he thought that students should be given the option of taking a course in highway engineering instead of railway engineering. The training would be equally good, but the point of view would be different and would better fit the student to become a city engineer or an engineer of road construction.

Prof. C. Frank Allen, in discussing the paper, seemed to voice the sentiment of many of the teachers of engineering, in saying that much of the work done by students in railway engineering is applicable to highway engineering. He maintained that no attempt should be made to teach the art of construction, but only the science of construction, and that roadbuilding is largely an art. He believed that the colleges were now giving enough time to the subject. For the sake of comparison it may be added that Mr. Johnson had stated that the average amount of time now devoted to railroad engineering in 15 of the most prominent technical colleges is 162 hours, as compared with only 32 hours devoted to highway engineering, and that in no college is any fieldwork given in road location or construction.

The other papers read at the morning session were: "The Teaching of Agricultural Engineering in Land Grant Colleges," by C. F. Zinthes, Professor of Farm Mechanics, Iowa State College; "Education of Mechanics," by Henry M. Lane, Editor of "The Patternmaker," Cleveland, Ohio; "Report of the Committee on Requirements for Graduation," by Wm. G. Raymond; "College for Artisans," by Frederick E. Turneaure, Dean of Engineering College, University of Wisconsin.

In the evening a joint session was held with the American Society for Testing Materials, at which the following papers were presented: "A Course of Laboratory Instruction in Applied Mechanics," by W. K. Hatt, Professor of Applied Mechanics, Purdue University; "The Testing Engineer," by C. B. Dudley, President Am. Soc. for Testing Materials; "A Course in Properties of Materials," by G. L. Christensen, Instructor in Mechanical Engineering, Michigan College of Mines; "Plan and Scope of Proposed Investigation of Structural Materials under the Auspices of the U. S. Geological Survey," by J. A. Holmes and Richard L. Humphreys.

THE RESIGNATION OF CHIEF ENGINEER JOHN F. WALLACE OF THE PANAMA CANAL COMMISSION.

Engineers throughout the country heard with the greatest surprise last week the news that Mr. John F. Wallace, Chief Engineer of the Panama Canal and a member of the recently created Panama Canal Commission, had resigned his position. His resignation was presented at an interview in New York on June 25 between Mr. Wallace and Secretary Taft. The causes which led to it have been set forth in an official statement by Secretary Taft and in one issued later by Mr. Wallace. Many of our readers have of course already seen these statements in the daily press; but for the benefit of those who are located where the metropolitan dailies are not accessible, we give the following extracts from these two statements:

Secretary Taft began by reciting the original appointment of Mr. Wallace as Chief Engineer of the Canal on May 5, 1904, with a salary of $25,000 per annum, and continued as follows:

Reorganization of the then Isthmian Canal Commission being then under consideration, Mr. Wallace wrote the Secretary of War on Dec. 20, 1904, as follows:

If you will kindly pardon me for doing so, I would like to make the personal suggestion that if the President and yourself should decide at any time to reduce the commission to three members resident on the Isthmus, the Governor of the zone and the Chief Engineer should be members of this commission ex-officio.

An organization of this kind, with the Chairman of the commission resident in Washington to look after general and departmental affairs, would no doubt work satisfactorily and be much less cumbersome than the present one.

And again on March 15, 1905, he wrote the Secretary:

I hope you will not consider me presumptuous if I respectfully ask that I be granted a personal interview before any radical change is decided upon in the governmental organization which would affect me unfavorably. I am not requesting additional emoluments of any nature whatever, but simply that no condition of affairs be created which will unnecessarily interfere with my efficiency here.

On March 24, 1905, the Secretary submitted to Wallace in detail, by cable, the plan of reorganiz which the President proposed to make (substantiall embodied in the subsequent Executive order of 1), and on the following day Mr. Wallace cabled Secretary as follows: "Plan excellent. Satisfa Gracias. (Thanks.)"

Thereafter the President issued his Executive orde April 1, creating a new commission and definin duties, among other things that of the Chief Engi as follows:

The head of the third department shall be the Engineer. He shall have full charge on the Isthmu
1. Of all the actual work of construction carried o the commission on the Isthmus.
2. The custody of all the supplies and plant of commission upon the Isthmus other than all supp needed for sanitary purposes.
3. The practical operation of the railroad on Isthmus, with the special view to its utilization in construction work.
4. He shall reside on the Isthmus and devote his tire time to the service, except when granted leave absence by the Secretary of War.

Mr. Wallace expressed his unequivocal approval of distribution of duties and powers as above defined the executive order, especially those relating to the of Chief Engineer, and during his subsequent stay six weeks in the United States daily participated w his associates in carrying out the same.

To the President, Secretary of War, members of commission, and its counsel, he frequently expres his unqualified approval and acceptance of the distribution of duties and powers as in the order embodied, and particularly those relating to himself, which required the performance by him of the duties of constructive engineer upon the Isthmus.

Mr. Wallace sailed for the Isthmus on May 17, accompanied by his family, and as late as May 26, wrote Mr. Cromwell from the Isthmus as follows:

In looking back over the events of the last few months I became more and more impressed with the wisdom underlying the action of the President and Secretary of War and the manner in which matters have been guided over the troubled waters of the sea of complication which has surrounded the situation.

He reached the Isthmus May 24, but on June 5, within twelve days thereafter, cabled the Secretary of War as follows:

To Secretary of War, Washington:

Important complicated business matters which cannot be arranged by correspondence and which may affect my relations as Chief Engineer of commission necessitate immediate return to the United States to confer with you and others. An order from you to return for official consultation will prevent apprehension on the part of the employes. Suggest Shonts remain until my arrival. Please answer.

WALLACE.

To this reply was sent the following day as follows:

Secretary of War and Shonts, in accordance with your request and without knowledge of circumstances that justify, approve your return for consultation with them at Washington.

By letter of June 4, addressed to the Secretary of War, Mr. Wallace states:

Certain complications are arising in my personal affairs which may render it necessary for me to go to the States on receipt of a cablegram at any time. Will you kindly cable me permission to do so? It is needless for me to say that I will not do this unless I consider it absolutely necessary.

On June 8, a few days before he sailed for New York, Mr. Wallace wrote the Secretary of War a letter in which he referred to his intended visit to the United States, but gave no explanation of his personal plans. Mr. Wallace arrived at New York the evening of June 22.

The Secretary made an appointment for a conference on Sunday morning, the 25th, at the Manhattan Hotel, in New York, the Secretary being then en route to New Haven.

The conference took place at the Manhattan Hotel as arranged. There were present the Secretary of War, Mr. Wallace, and Mr. Cromwell, who for some time had been charged by the President and Secretary with general advisory duties in all Panama Canal affairs.

Mr. Wallace stated that part of the interview would be personal to himself and part would concern the general canal work on the Isthmus. The Secretary referred to the foregoing cables and acquiesced in Mr. Wallace's suggestion that he first speak of the personal matters.

Mr. Wallace then said that a few days before he sent the cable message to the Secretary, he had received a dispatch from prominent business men in New York asking if he would consider an offer to accept an important place in New York, and that he had cabled in reply that it was "simply a question of terms and conditions," and that he had requested particulars; that the particulars came, and it proved to be a definite offer of a place as President of a large holding company controlling several other corporations with certain stock benefits and other advantages to himself, which, with the salary, made it equivalent to $50,000 a year; that he did not at once accept the offer, but delayed it a few days in order to cable the Secretary of War, during which the parties increased their proposal between $10,

60[illegible] $15,000 a year, making it equivalent to $60,-
60[illegible] $65,000.

He stated that the place was an especially desirable one and such as he had only hoped to obtain after the completion of the canal, and thus only after years of further service on the Isthmus; that the duties of the new place were especially agreeable and afforded opportunities to make money through investments, etc.; further, that the place was such a good one that he did not consider that he could decline it; that the life on the Isthmus was lonely and accompanied with risk to himself and wife, and was another reason for accepting a better offer, but that his new duties would not require all of his attention for the next two months, and that the parties had agreed that he could close up his canal work in the meantime, always provided that it did not take him from New York to the Isthmus.

He referred to the President's order, appointing the original commission, and in which the President had stated that the Commissioners would hold office subject to the due fulfilment of their duties, and he stated that this made the office subject to termination by the President, and that consequently he (Wallace) considered that the holder of the office had an equal right to retire from it at his option at any time.

Concluding, he stated that while he was thus severing his connection with the canal work he was willing to make up his annual report and he would, if desired by the Government, continue to serve as a Commissioner, but not as Chief Engineer in charge of the construction work on the Isthmus.

Mr. Wallace said that was all he had to say in regard to his personal relation to the work, and that he would then proceed to discuss generally the conditions on the Isthmus if the Secretary desired. Secretary Taft said he wished Mr. Wallace would continue his general statement.

Mr. Wallace then discussed conditions on the Isthmus and the work impersonally for half an hour.

Secretary Taft then proceeded to severely arraign Mr. Wallace for giving up his position so soon after receiving the appointment. He took the ground that in accepting so great and responsible an office, Wallace was under moral obligations to fulfil its duties for at least a reasonable time. He finally concluded by asking Wallace to present his immediate resignation.

Mr. Wallace in reply expressed a desire to do everything possible to advance the interests of the work while relinquishing the Chief Engineership. He offered to make up his annual report and to serve in an advisory capacity for such time as might be desired. The Secretary refused to consider this and the interview terminated with the formal presentation by Mr. Wallace of his immediate resignation.

On Saturday, July 1, Mr. Wallace presented his side of the case in a published statement from which we quote as follows:

The primary causes which led me to tender my resignation as Chief Engineer of the Isthmian Canal Commission were underlying and fundamental, and I must emphatically resent the charge that my motive in leaving the work was a financial one.

A careful consideration of the entire subject had brought me to the decision that I should disconnect myself with the work at the earliest possible date that it could be done without embarrassment to the Administration or injury to the work. It is unnecessary to state the reasons for this decision except that in fairness I should say that they involve no criticism of any act of the President or the Secretary of War.

My final decision was arrived at as the result of the six days uninterrupted thought which I was able to give the subject in all its bearings during my voyage from New York to Colon in May. Furthermore, I had pledged myself to my family to give the matter of my resignation as chief engineer, or of any position which would require my continuous residence on the Isthmus, serious consideration.

It was at this psychological moment that I received a cablegram from New York offering me a business opportunity which I was bound to consider. I therefore immediately cabled the Secretary of War requesting a conference, and arrived in New York for that purpose on Thursday, June 22. * * * *

If the Secretary understood me to say that I had accepted a position in New York, he labored under a misapprehension. I did state to him that I desired to accept one, but under such circumstances and conditions and at such time as would cause the least embarrassment to the Administration and the least injury to the work, and that I was even willing to go to the extent of remaining for an indefinite time on the commission should he desire my counsel and advice in arranging for the change, assisting in preparing plans for submission to the advisory board of engineers in September, or in the further consideration of the question by the Administration or Congress during its next session.

Much to my surprise he indignantly spurned my suggestion and took the position that I was compelled under what he called my contract to remain in charge of the Isthmian Canal, regardless of circumstances or conditions, until the completion of the work, and spoke in such a manner as to outrage my feelings to such an extent that further discussion of the reasons for my action was out of the question.

I did not seek the position of chief engineer of the Isthmian Canal Commission, and, considering my salary as General Manager of the Illinois Central Railroad Company and my other sources of earnings, my financial condition was not improved by my acceptance of the position, and it was with the greatest reluctance that I did so.

While it was my own expectation that I should continue my connection with the work, it did not occur to me that I was not free to withdraw if justice to myself and my family, and to my reputation as an engineer, required me to do so. It was not only my right, but my duty to give the matter the most careful consideration in all its bearings, considering not only the general situation as it affected the work, but my family, personal and business relations, and all the various factors entering into the problem, and I could not concede the right to the Secretary of War or any one to dictate my decision. The only deliberate questions were the details as to putting my decision into effect, and while I stated to the Secretary what my desires were I told him that I was perfectly willing to conform to his wishes as far as possible, as to the time and manner of my withdrawal.

It was this suggestion to which he chose to refer as a "dicker." To that statement I naturally took exception, particularly as he stated that he did not care for any reports that I might make summarizing and analyzing the results of a year's hard work on the Isthmus; also, that he did not value my counsel and advice, and that the only service he desired was that of a constructing engineer on the Isthmus.

No intimation of friction between the Secretary of War and myself would have become public if it was not accidentally, or otherwise, given out by the persons in attendance at the conference on Sunday other than myself, and I desire to state emphatically, and the representatives of the press will bear me out, that I have refused absolutely, either directly or indirectly to be interviewed, and have remained silent under the innuendoes which have been daily published since the conference, and would not have made even this statement at this time if it had not been for the severe strictures contained in the published statement of the Secretary, which I consider unjust and uncalled for, and which could serve no useful purpose.

In regard to the situation at Panama, at no time during the progress of the work could my relations have been severed more opportunely than now, and with less damage to the work. A complete organization of departments and bureaus has been effected. Mr. W. E. Dauchy, a gentleman of high engineering attainments, who has been chief engineer of the Chicago, Rock Island and Pacific Railroad Company, and who had occupied the position of division engineer in charge of the Culebra division, was upon my leaving the Isthmus placed in charge of the work as acting chief engineer, he having occupied a similar position during my absence from the Isthmus at the call of the Secretary during the month of April and having satisfactorily conducted the work through the demoralization attendant upon the change in organization.

The only work which can be performed until after Congress at its next session shall take some decided action is the gradual increase in the organization and the addition of units of machinery along a well-defined plan which Mr. Dauchy thoroughly understood.

The simple work of excavating at Culebra and preparing for further excavation are the only things which could be done pending a final decision from Congress. The only possible benefit that my personal service as Chief Engineer could have been to the work was such as might be due to the purely personal element, which would have been largely supplied by my continuance with the work in an advisory capacity. As far as the actual engineering and construction work was concerned Mr. Dauchy was fully as capable as I.

Despite all of the discouragement and obstacles which have surrounded this work, as the Secretary knows and has practically stated in his letter, I endeavored to faithfully and vigorously perform the duties of my office and have never complained or criticised my superiors or any one connected with the work, and, as stated in the Secretary's communication, I have never requested additional emoluments or asked any favors of a personal nature, and any suggestions which I may have made, as his statement will bear me out, have been made because I considered them necessary for the increased efficiency of the work.

The reorganization of the work in April was not considered ideal, but as it was such a decided improvement over the existing condition of affairs and seemed to be all that could be done under existing laws I gave it my hearty approval.

I have made no criticism of personnel or individuals, but do believe that the obstacles due to the governmental methods required by existing laws are so serious that they will have to be eliminated if the American people are to see the Panama Canal constructed in a reasonable time and at a moderate cost.

My only desire in this statement has been to protest against what I consider the unjust denunciations of the Secretary, and to fully inform my personal friends and professional brethren who have been familiar with my career, of the essential facts relating to this matter. I emphatically disclaim all responsibility for the various statements recently published alleged to have been made by so-called friends.

ANNUAL MEETING OF THE AMERICAN SOCIETY FOR TESTING MATERIALS AT ATLANTIC CITY, N. J.

The annual meeting of the American Society for Testing Materials, held at Atlantic City, N. J., during Thursday, Friday and Saturday of last week (June 28 to July 1, 1905), was highly successful both in attendance and in work done. Last year's meeting,* also held at Atlantic City, made it clear that the society stood second to no other technical society of this country in the value of its work and in the active interest of its members. The meeting of this year reinforced that demonstration in every particular. About a dozen different committees charged with developing standard specifications in as many different fields reported work in various stages of completion, and three or four others reported their organization and plans for study in their respective subjects. In addition, about twenty professional papers were read. Nearly two hundred members were present at the meeting, and each of the seven sessions of the meeting was well attended. The very fact that a society is able to hold seven sessions in three days within speaking distance of the crowded "Boardwalk," and secure large and interested attendance at each, is evidence of its abundant vitality.

The Society for the Promotion of Engineering Education held its annual meeting there at the same time, and one session was held jointly by the two societies. This was the session of Thursday evening, June 29, when President C. B. Dudley delivered the Presidential address, on the subject "The Testing Engineer."

While the record set by last year's meeting in work on specifications—the virtual adoption of standard specifications for Cement, Foundry Pig Iron, Cast Iron Pipe, Locomotive Cylinders, and Malleable Castings—is of such high order that it may appear difficult to excel, yet the work of the year just closed is to say the least fully up to that record. Committee A, on Iron and Steel, formulated separate specifications on Structural Steel for Bridges, Structural Steel for Ships, Steel Rails, Steel Castings, Steel Axles and Steel Forgings; these were accepted by the society at its meeting and will probably soon be established as standards by general ballot of the society. Committee B, on Cast Iron, proposed and passed two complete specifications, those for Gray-Iron Castings and for Cast-Iron Car Wheels respectively. Thus some of the most important and widely-used materials in industrial work, Cement, Structural Steel, Rails, Pig Iron, Gray-Iron, are now covered by general specifications drawn up with greatest care and with a thorough study of all the interests involved. It merits special mention, further, that in the case of each specification, but more particularly in cases where other (and perhaps several conflicting) specifications already existed, every effort was made to harmonize differences and present something that might fairly be accepted by all parties as a common standard. Notable instances of this occurred in the work of Committee A (Iron and Steel), and in fact most of the specifications there adopted represent the joint product of the society and one or more other interested organizations.

Beside the work of the two committees specially mentioned above, much that is less conspicuous was accomplished at the present year's meeting. A great range and amount of investigation has been initiated or already planned and organized; special interest attaches to the Committees on Grading Structural Timber, Fireproofing Materials, and Standard Methods of Testing, each of

*Fully reported in Engineering News of June 23, 1904.

which has a remarkably large field of study and will probably enter into extensive experimenting.

RELATIONS WITH THE INTERNATIONAL ASSOCIATION.

The administrative business transacted by the society at this meeting was not large in amount, but included one weighty matter, a discussion of whether or not the society shall separate itself from the International Association for Testing Materials, to whom it has hitherto made a contribution—virtually a gift—of $000 to $1,000 yearly. The conditions underlying and surrounding the question at issue are somewhat complex. We therefore, in spite of the importance to the society (and perhaps to wider circles) of the step taken as a result of the discussion, omit detailed review of the matter, at the present moment, and confine ourselves to a brief statement of the nature and outcome of the discussion. The question was brought up through a proposed amendment to the by-laws of the society, proposed by the Executive Committee, which amendment eliminates the annual payment of $1.50 per member which the society since its formation has contributed to the International Association. The amendment is founded on the fact that practically no return whatever has been received for this contribution, in consequence of which fact the executive committee, as trustee of the interests of the society and the individual members, was forced to the conclusion that the payment should be discontinued. A suitable amendment was, therefore, proposed for adoption, as announced by circular to the membership some time ago. When this amendment came up for discussion at the meeting, Mr. R. Moldenke (Watchung, N. J.) opposed it strongly, on the ground that it would disturb or tend to disturb the fraternal feeling hitherto existing between the interested circles in Europe and America respectively. He asserted that if the society cut off its regular contribution a very bad feeling would be created in Europe, where the feeling toward America is, because of industrial competition, none too good at present. The contrary side was upheld with the argument that the society must follow business principles in its dealings; that the several thousand dollars sent to Vienna during the past few years have brought in no return whatever, because the International Association has held no congress and has published no papers or discussions, in fact, nothing but one or two brief circulars; and that even the business correspondence between the society and the association has been so unsatisfactory (in some cases letters from this country being left quite unanswered) as to indicate a fatal lack of harmonious cooperation between the two organizations. This side of the matter was presented by Prof. Edgar Marburg (Philadelphia, Pa.) and Mr. Charles B. Dudley (Altoona, Pa.), respectively secretary and president of the society, Prof. Mansfield Merriman (Bethlehem, Pa.), Mr. R. W. Lesley (Philadelphia, Pa.), and Mr. W. R. Webster (Philadelphia, Pa.) The negative side, championed by Mr. Moldenke, was supported, partially at least, by Mr. Charles Major (Pencoyd, Pa.), and Mr. Paul Kreuzpointner (Altoona, Pa.) Mr. Major offered the view that international unification of specifications for materials is highly important to business intercourse, and that a step as proposed would therefore not be justified, at any rate, before such unification had been secured. But it was pointed out by Mr. Webster that the International Association has ever been rigidly opposed to the formulation of specifications, and that no prospect exists that it will accomplish much in such work in the future.

The meeting finally adopted a resolution that the proposed amendments be submitted to letter-ballot of the membership, and that, if they are adopted, the executive committee be directed to continue the society as an individual member of the International Association with an annual contribution of $100.

Other business proceedings were the presentation of the annual report of the executive committee and the election of two new members of that committee. Mr. W. A. Bostwick (Pittsburg, Pa.) and Mr. John McLeod (Pittsburg, Pa.) were elected. The report of the executive committee shows a large and steady increase in membership, the largest yearly increase in the society's history. The past year's accession of 192 brings the membership to 677. The financial condition of the society is sound, a small but increasing cash balance being reported. Receipts and expenditures are about $6,000 each.

Professional Proceedings.

COMMITTEE ON STANDARD METHODS OF TESTS.—This committee, under the chairmanship of Prof. Gaetano Lanza (Boston, Mass.), has only recently been organized. A preliminary scheme of subdivision of the field has been prepared. This scheme is extremely comprehensive, and includes subjects of great importance. The committee will probably confine itself to mechanical testing.

COMMITTEE ON UNIFORM SPEED IN COMMERCIAL TESTING.—A very full preliminary report was presented by the chairman, Mr. Paul Kreuzpointner (Altoona, Pa.), outlining the reasons why it is important to know if any difference in tensile test results appears between tests made at the speed of 1-in. per minute and tests made at the speed of 6 to 8 ins. per minute. Rapidity of testing is a simple means of increasing the output of a busy testing laboratory, but it may be countenanced only if it agrees with slower speed results within the limits of experimental differences. To clear the question a large number of tests was made, using the same materials at two or three different speeds. Ordinary grades of steel (55,000 to 145,000 lbs. tensile strength) and staybolt iron were tested, as the question at issue affects these materials almost exclusively. The results are summarized as follows:

> We find that out of 20 cases of differences in per cent. of elongation due to differences in speed, the difference is less than 1% in 13 cases (in steel as high as 0.45 and 0.50% carbon), and in the remaining seven cases, where the difference exceeds 1% elongation, the elongation is lower in five cases of higher speeds and higher only in two cases. In one case, where the difference in strength between the 1-in. and 8-in. speeds showed the unusual figure of 11,900 lbs., the elongation is yet only 0.3% lower with 8-in. speed than with 1-in.; this is in a ½-in. bar of 0.60% carbon, where we might expect a larger decrease of ductility due to rolling.
>
> In analyzing the differences of the averages in strength it is found that, with boiler steel, the greatest difference between a ¾-in. and a 6-in. speed is 2,080 lbs. (and 4.3% elongation), while the maximum difference between individual test-pieces was 1,970 lbs. (and 4.5% elongation).
>
> Interpreting the results of the preliminary work of your committee with the help and guidance of related scientific phenomena, we may fairly assume a 6-in. speed of testing for commercial purposes, of metal of 0.45% carbon and less, as acceptable without detriment to the reliability of the results.

The report was accepted. The committee will continue work on the subject.

COMMITTEE ON FIREPROOFING MATERIALS.—Prof. Ira H. Woolson (New York, N. Y.), chairman, made a brief report of the recent organization of the committee. It is planned for the present to study some of the large classes of fireproofing, as floors, column-coverings, and partitions.

COMMITTEE ON STANDARD SPECIFICATIONS FOR THE GRADING OF STRUCTURAL TIMBER.—This is another recently-formed committee. Mr. Herman von Schrenck (Washington, D. C.), chairman, sketched the great value of a uniform basis of grading and the large scope of the work, covering as it does a great number of words having quite different conditions, properties and applications. Prof. W. K. Hatt (Lafayette, Ind.) mentioned the survival of old-fashioned or erroneous specifications in use, such as the rejection of bied long-leaf yellow pine; the work of the committee will include the elimination of such clauses.

Of related interest was a short address by Mr. J. A. Holmes (Washington, D. C.), on the proposed investigation of structural materials, especially timber, by the United States Geological Survey. In the direction of this work the bureau will have the advice of a committee of engineers in private life, and the active assistance of the Bureau of Forestry, the latter working on the forest side of wood values and on wood preserving to the end that each wood may be given its proper place and its full value. Prof. G. Lanza (Boston, Mass.) mentioned in connection with this subject that the Watertown Arsenal intends to adopt the practice of publishing its work in bulletins at short intervals, instead of waiting to bring it together in annual reports. Mr. R. W. Lesley Philadelphia, Pa.) referred to the great amount of experimental study done by the Government in the past, most of which work is virtually buried, and congratulated the proposed investigation on being a means for not only experimenting but also publishing results. Ultimately, he said, this may perhaps lead to the ideal of a great government experiment station.

COMMITTEE ON STANDARD SPECIFICATIONS FOR CEMENT.—As the standard specifications for Portland and natural cements were adopted less than a year ago, there has not been sufficient time to show how well they meet approval. No changes or comments, therefore, were proposed at the present meeting.

COMMITTEE ON REINFORCED CONCRETE.—Prof. F. E. Turneaure (Madison, Wis.), chairman, reported that this committee has associated itself with committees of the American Society of Civil Engineers, the American Railway Engineering & Maintenance-of-Way Association, and the Association of Portland Cement Manufacturers. Considerable experimental work has been done, and more is planned at various laboratories.

One part of the work done or to be done in aid of this committee was reported on by Prof. Ira H. Woolson (New York, N. Y.) in a paper entitled "Investigation of the Effect of Heat upon the Crushing Strength and Elastic Properties of Concrete." A large series of careful experiments, summarized in this paper, was conducted to show whether and how much concrete is weakened by exposure to temperatures of 500° to 2,000° F. Parallel observations of ultimate crushing strength and modulus of elasticity were made. The paper will be reproduced in a future issue of Engineering News.

This paper aroused great interest since it presented the only laboratory experiments that have ever been published on the subject. The tests were made on 1:2:4 concrete, using limestone for one series of tests and trap for another series. It was found, for example, that 30-day cubes of both kinds of concrete had a compressive strength of 1,800 lbs. per sq. in. An increase of 500° temperature had no appreciable effect upon the trap concrete, but beyond that temperature the strength fell off steadily until at 2,250° the cubes showed but 500 lbs. per sq. in. The limestone concrete showed an almost uniform loss of strength until at 1,750° the strength was 800 lbs. per sq. in. At 2,000° it had no compressive strength.

In discussing the paper Mr. R. L. Humphrey (Philadelphia, Pa.) seemed inclined to question the value of laboratory tests on a small scale, since the heat effect upon large masses of concrete is much less injurious than upon small masses. In this Mr. R. W. Lesley (Philadelphia, Pa.) agreed, as did also the author of the paper, who explained that his object was to investigate the relation between temperature and strength. He was well aware of the importance of the element of time in heating concrete, and that due to its poor conductivity the concrete in a large mass is not injured by heat much beyond an inch in depth. Mr. L. C. Wason (Boston, Mass.) stated that it is his practice to add an extra inch of concrete to the face of walls likely to be exposed to fire. Then, in case of fire the surface can be replastered.

Mr. R. P. Miller (New York, N. Y.) stated that in testing 12 reinforced concrete structures, the New York Building Department had found that about half the structures were not injured by fire, but that the other half were somewhat damaged. During the first half hour of the fire, water pours out from the sides of the concrete room in great quantities, particularly if the concrete is new, and slight explosions of steam occur, often spalling off fragments of concrete. As a rule, however, the injury to the concrete appeared not to extend to a greater depth than 1 in., under a four-hour test. The older the concrete the better it stands the test.

It was stated in the discussion that Mr. R. L. Humphrey has records of tests which show that steel rods whose surfaces are 2 ins. from the face of the concrete are not injured either temporarily or permanently by a temperature of 2,000° maintained for four hours at the face of the concrete.

Thermometers imbedded in the concrete at different distances from the surface had been used to ascertain the exact temperatures. The results of this test would be published later. Prof. Woolson called attention to the fact that his paper shows that it takes four hours for concrete 3 ins. from the surface to be raised to 750°. Several of the speakers mentioned the fact that concrete after dehydration by heat will again take up water and harden. One speaker said that briquettes heated to 1,000° for 6 hours were put into a tank of water and at the end of 28 days had rehydrated to such an extent that they showed 75% as much strength as the ordinary 28-day briquettes that had not been heated.

A paper by Mr. R. S. Greenman (Albany, N. Y.) on "Normal Consistency Tests of Neat Cement," opened the entire question of time of initial set of cements, by showing that the recommended standard method of fixing the normal consistency to be used in this test, namely, by making an auxiliary Vicat-needle test and finding the amount of water required to obtain 10 mm. penetration, is unreliable and practically not of general application. The conclusions drawn from a series of comparison tests covering 15 brands of cement are thus expressed:

The Vicat apparatus is not satisfactory for all brands and samples of cement, inasmuch as it frequently fails to produce a required penetration of 10 mm. unless the cement be almost flooded by an excess of water. The method could perhaps be well recommended as a general aid to one not acquainted with the characteristics of the various brands, but it is hardly reliable enough to be used as a determining factor in case of a dispute between laboratory and sales-agent, if the experience of the expert is pitted against the mechanism of the apparatus.

That the consistency of the cement paste and the percentage of water used in gaging the paste have a very decided bearing on the time of setting is our experience. We found . . . that even 1% of water will so affect the consistency that a quick-setting cement will fail or pass the specifications for initial set, while one of the cements tested in this series was rejected by the State Architect because of the slow hard setting developed by having used the amount of water necessary to produce a consistency based on the requirements of the Vicat needle apparatus.

The series of tests showed the influence of 1% of water to cause the initial set to vary from nothing to 183% in ordinary cases, while in one case it made a difference of 880%. The average difference in time caused by 1% of water was about 25%.

Mr. Greenman added that the State of New York will use about 350,000 bbls. of cement per year on the Barge Canal work, and 140,000 bbls. per year on good roads construction. In the roadwork the cement is bought in small lots, often from local dealers, and it then shows less uniformity and reliability under the tests than when bought in large orders.

In the discussion of this paper Mr. L. C. Sabin (Sault Ste. Marie, Mich.) was inclined to believe that the author's trouble in getting satisfactory results with the Vicat needle was due to the method of packing the mortar in the ring. Mr. W. A. Aiken (Pittsburg, Pa.) was inclined to believe that the needle test for consistency is fairly satisfactory where numerous brands were to be tested, but that it is too slow where the work is all upon one brand. Mr. R. L. Humphrey was doubtful as to whether the author had followed explicitly the specifications for making the needle test, and could not see how such wide variations could occur. Mr. Greenman replied that he was not the only one in his department who found the test unsatisfactory. He spoke for the whole department in questioning its value. The tests had been performed as specified, and upon a great variety of brands—58 brands having been tested last year.

A paper on "Low-Pulling Early Stage Portland Cement vs. the Ordinary Early Strength Developing Product," by Mr. W. A. Aiken (Pittsburg, Pa.) showed, from the experience of the New York Rapid Transit Commission's cement laboratory, that Portland cement having a neat 7-day tensile strength below 700 lbs. per sq. in. has a larger increase in strength subsequently than a cement which develops over 700 lbs. at 7 days.

Messrs. Clifford Richardson and C. N. Forrest (Long Island City, N. Y.) presented a paper entitled "An Economical Mold for Forming Compressive Test Pieces for Concrete," which describes a cylindrical 6-in. mold in place of the 6-in. cube mold. The mold may be made at a much lower cost than the cube mold, and the test results of the cylindrical briquettes show little difference from results on cubes, the former running a little higher in neat and sand mixtures and a little lower in concrete. The cylinder mold is made of 1/8-in. steel rolled to form a 6-in. cylinder if closed, but left open ½ in. normally; a ring surrounding the mold, with pressure screws, closes the mold and facilitates stripping.

Prof. William K. Hatt (Lafayette, Ind.) had used cylinder molds, but favored a cylinder 8 ins. in diameter instead of 6 ins. Prof. Edgar Marburg stated that he had found it advisable to use tin cylindrical molds, which were not only cheap but facilitated the shipping and handling of the test pieces. The tin is readily stripped off just before testing.

The remaining proceedings of the Convention are postponed to our next issue.

THE NEW YORK SUBWAY will be open for trains from the Battery to the Bronx on July 15, according to announcement. That is, the portions of the subway beneath the Harlem River and on lower Broadway will be opened to traffic.

THE NUMBER OF EMPLOYEES AT PANAMA on June 1 is reported by the office of administration of isthmian canal affairs as a grand total of 9,702 persons employed on the isthmus in canal work. Of this number 1,493 are "gold" employees (those paid in United States money and having certain perquisites), practically all of whom are Americans, and 8,209 are "silver" employees (those paid in pesos, or native Panama dollars, and not having the perquisites of the gold members), and practically all of these are natives of the isthmus, or of the adjacent West Indian Islands. During May there were six deaths from yellow fever on the isthmus, two canal employees and four Americans without employment being among the number; while in June there have been nine deaths from yellow fever, four of whom were canal employees, the others being French, Spanish and Italian non-employees.

THE CONSTRUCTION OF A TOWER 560 ft. high for the new Metropolitan Building at 23d St. and Madison Square in New York city has been widely announced in the daily papers. An investigation of this announcement shows it to be largely false. Some years ago when the first designs for the building were prepared a high tower was made a feature, but this tower was not 500 ft. high nor is it definitely settled that it will be built. No plans have been prepared for construction nor has the architect been notified that plans will be wanted in the near future.

A TRAIN BULLETIN has been adopted by the Chicago & Alton Ry. for use in railway stations and also in hotels at towns along the line in order to advise the public as to whether trains are on time or late. In the center is a pointer and on each side of this are printed "5 mins. late," "2 hours late," etc. At the top is the record "on time," and at the bottom is the designation of the train. The apparatus is operated by electricity and all the bulletins in one town are operated simultaneously from the railway station. The device is intended to save persons the inconvenience of getting to the station too soon, but it is rather a discouraging commentary on railway operation when trains are so generally and so seriously late (the bulletin going as high as "5 hours late" and "abandoned"), that it is considered necessary as desirable to introduce such an elaborate system of announcing the fact.

GAS ENGINES OF 5,400 B. HP. are being built for the new power station of the California Gas & Electric Co., at San Francisco, Cal., by the Snow Steam Pump Works, of Buffalo, N. Y. There are four of these engines, three of which will operate three 25-cycle alternating-current generators of 4,000 KW., while the fourth will operate a 60-cycle alternating-current generator of 4,000 KW.

EXTENSIVE RAILWAY TERMINALS at New Orleans, La., for the use of the St. Louis & San Francisco Ry., are now being constructed by the New Orleans Terminal Co. The work includes a freight belt line and connection with new ocean steamship piers at Chalmette (6 miles down the river), a large new passenger terminal station in the center of the city, and six large brick freight houses; also yards, docks, a 500,000-bushel elevator, etc. Three of the freight houses have been built and the others are under construction; 11 miles of sidetracks have already been laid, and a great many more miles have yet to be laid. The plans for the passenger terminal have not been prepared. The export facilities at Chalmette will be very extensive, and the construction of these has been commenced. Here there will be a slip 1,500 ft. long and 250 ft. wide, with freight sheds 150 ft. wide along each side. Owing to the lesson taught by the costly fire at the Stuyvesant docks of the Illinois Central R. R. at New Orleans, all the warehouses and buildings will be of brick and steel construction. Mr. L. S. Berg is President of the New Orleans Terminal Co., and Mr. F. G. Jonah, M. Am. Soc. C. E., is Terminal Engineer. Stewart Bros., of Chicago, have the contract for the slip and other works at Chalmette; and Geo. B. Swift & Co., of Chicago, have the contract for the various buildings.

A NEW WATER-WORKS LAKE TUNNEL FOR DETROIT, Mich., has just been completed. The tunnel is 3,160 ft. long, c. to c. of shafts, has an internal diameter of 10 ft., and a four-ring brick lining. There was 26 ft. of clay between the bottom of the river and the top of the excavation. The greatest depth of water over the tunnel is 30 ft. The tunnel bore, which was 13 ft. in diameter, was through clay containing pockets of sand. Air pressure of 12 to 32 lbs. was used, and no shield was employed. There was no loss of life during the construction of either the tunnel or shafts. The river intake crib will not be completed until some time next fall. Mr. Clarence W. Hubbell, M. Am. Soc. C. E., is Civil Engineer to the Water Board of Detroit.

BIDS FOR GARBAGE COLLECTION AND DISPOSAL at Philadelphia during the year 1906 are to be readvertised and then opened on July 13. On May 4, 1905, bids were opened by ex-Director of Public Works Costello as follows: Urban Waste Disposal Co., 25 Nassau St., New York, $444,000; Owen J. Evers, $448,300; James Curran, $524,000; American Product Co., $538,000. The contract has been held, year by year, for a number of years past, by the American Product Co., which has treated the garbage by the Arnold, or Arnold-Edgerton, reduction system. No specific official reason for rejecting the former bids has been given, but it is reported that the principal cause for the action was the fact that the lowest bidder, although nominally a New York company, was in reality in the same interests as the principal in the filtration contracts now under investigation.

ENGINEERING MATERIAL PRICES.

TRACK FASTENINGS—
Chicago—at mill—Angle bars, 1.40 to 1.50 cts.; spikes, 1.75 to 1.85 cts.; track bolts, 2.40 to 2.50 cts.

RAILS, STEEL—
New York—at mill—New standard sections, $28; standard, second quality, $27; light sections, 12 to 25 lbs., $20.50 to $23; old iron, f. o. b. New York, $16.50 to $17.50; old steel, rerolling lengths $13.25 to $14.25; old steel, short pieces, $13 to $14; relayers, $20 to $21.
Chicago—at mills—New, $28, standard sections; light rails, $24 to $27; old iron, $17.25 to $17.50; old steel, 4 ft. and over, $13 to $13.50; old steel, less than 4 ft., $12.50 to $13; heavy relayers, $22.25 to $22.75; heavy relayers for side tracks, $19.50 to $20.
Pittsburg—at mill—Standard sections, $28.

STRUCTURAL MATERIALS—
New York—at tidewater—Beams, channels, angles and zees, 1.74½ to 1.84½ cts.; tees, 1.79½ to 1.89½ cts.; bulbs, angles and deck beams, 1.84½ to 1.94½ cts.
Chicago—Beams and channels, 3 to 15-in., inclusive, and angles 3 to 6-in., ¼-in. and heavier, 1.76½ cts.; tees, 3-in. and over, 1.81½ cts; beams, larger than 15-in., 1.86½ cts.; tees, 3-in. and over, 1.76½ cts.
Pittsburg—Beams and channels, up to 15-in., 1.60 cts.; over 15-in., 1.70 cts.; angles, 3 × 2 × ¼-in. thick up to 6 × 6-in., 1.60 cts.; angles, 8 × 8 and 7 × 3½ in., 1.70 cts.; zees, 3-in. and larger, 1.60 cts.; tees, 3-in. and larger, 1.65 cts.

PLATES AND SHEETS—
New York—at tidewater—Sheared plates, tank, 1.74½ to 1.84½ cts.; flange, 1.84½ to 1.94½ cts.; marine, 1.94½ to 2.04½ cts.; fire box, 1.94½ to 2.50 cts.
Pittsburg—Tank, ¼-in. thick, 6¼ to 14-in. wide, 1.50 cts. at mill, Pittsburg; flange and boiler steel, 1.60 cts.; marine and ordinary fire box, 1.70 cts., at mill, Pittsburg; locomotive fire box, 2 cts.

MERCHANT STEEL—
Chicago—Machinery, smooth finished, 1.91½ cts.; tire, smooth finished, 1.86½ cts.; railway spring, 1.86½ cts.; crucible tool, 6½ to 8 cts.; special tool, 13 cts. and up.
Pittsburg—Railway spring steel, 1.65 to 1.70 cts.; smooth finished tire, 1.65 to 1.70 cts.; smooth finished machinery steel, 1.70 to 1.75 cts.; crucible tool steel, ordinary grades, 5¾ to 7 cts.; extra grades, 10 cts. and up.

IRON—
Pig Iron:
New York—No. 1 X Foundry, $16.25 to $16.75; No. 2 X Foundry, $15.75 to $16.25; No. 2 plain, $15.25 to $15.75; Gray Forge, $14.25 to $14.75; Basic, $15.25 to $15.75; Southern No. 1 Foundry, $15.50 to $16.00; Lake Superior Charcoal, $16.50 to $17.00; Northern Coke Foundry, No. 1, $16.75 to $17.00; Northern Coke Foundry, No. 2, $16.25 to $16.50; Northern Coke Foundry, No. 3, $15.75 to $16.00; Northern Scotch, No. 1, $17.00 to $17.50; Ohio Strong Softeners, No. 1, $17.30; Ohio Strong Softeners, No. 2, $16.80; Southern Coke No. 1, $15.65; Southern Coke, No. 2, $15.15; Southern Coke, No. 3, $14.65; Southern Gray Forge, $14.15; Southern, Mottled and White, $13.90; Malleable Bessemer, $16.25 to $16.50; Standard Bessemer, $16.80 to $17.05; Alabama Basic, $15.90 to $16.15.
Pittsburg—Foundry iron, Northern, No. 2, $14.50 to $14.75, at Valley furnace; Gray Forge, Northern, $14, at Valley furnace; $14.85 at Pittsburg; Bessemer and Basic, $14.50 at Valley furnace; $15.35 at Pittsburg.
Cast-Iron Pipe:
New York—Carload lots, net tons, 6-in., at tidewater, $27.
Chicago—4-in. water pipe, $29; 6-in. and larger, $23, with $1 extra for gas pipe.

MISCELLANEOUS MATERIALS—
Asphaltum:
Ventura and other California asphalts, $20 to $21 per ton at New York; Trinidad refined, $25 to $30 per ton; Venezuela asphalt, $25 to $30 per ton; Bermuda asphalt, $25 to $30.
Cement:
Rosendale, in wood, $1; Portland, domestic, $1.70 to $1.80; Foreign brands, $2.25 to $2.50.
Copper:
Lake, 15 cts.; electrolytic, 15 cts.; casting, 14.75 cts.
Lead:
New York, spot, 4.50 to 4.60 cts.
Spelter:
New York, spot, 5.40 to 5.50 cts.
Tin:
New York, spot, 29.87½ to 30.25 cts.

LUMBER—
New York, wholesale prices:
Piling—Spruce, ordinary cargoes, 6 to 7 cts.; oak, 14-in. butt, 40 to 50 ft., 19 cts.; 50 to 55 ft., 22 cts.; 55 to 60 ft., 23 cts.; 60 ft. and up, 25 cts.; pine, 60 to 65 ft., $8.50; 70 to 75 ft., $10.50; 80 ft. and up, $16.
Railroad ties—Yellow pine, 6 x 9 ins. x 8 ft., 58 to 59 cts.; 6 x 8 ins. x 8 ft., 53 to 54 cts.; 7 x 9 ins. x 8 ft., 64 to 65 cts.; 7 x 8 ins. x 8½ ft., 59 to 61 cts.; 7 x 9 ins. x 8½ ft., 64 to 66 cts.

PERSONALS.

Dr. Wm. R. Batt, of Philadelphia, has been appointed State Registrar of Vital Statistics, under the newly organized State Department of Health.

Mr. Edward J. Lamster, of Jersey City, N. J., has been appointed Architectural Draftsman, Isthmian Canal Commission, for duty on the Panama Canal.

Mr. C. McKay Watts has resigned as Principal Assistant Engineer of the Wabash-Pittsburg Terminal Ry. Mr. W. J. Coursin has resigned as Assistant Engineer.

Mr. Herbert W. Griswold and Miss Jeanette D. Phillips, of Columbus, O., were married on June 21, at Liberty O. Mr. Griswold is a Civil Engineer at Worthington, O.

Mr. George H. Richardson, of Allentown, Pa., has been appointed Supervisor of Mines, Isthmian Canal Commission. Mr. Richardson sailed for the Isthmus on July 5.

Mr. G. F. Ashton, City Engineer of Salem, Mass., and Miss Helen Archer, daughter of Mr. and Mrs. C. F. W. Archer, of Salem, were married on June 28. They will reside on Ocean Avenue.

Mr. Wallace C. Johnson, M. Am. Soc. C. E., Commissioner of River Improvements, State of New York, has had the degree of Master of Arts conferred upon him by Williams College.

Mr. Ira P. Cribb, of Canandaigua, N. Y., and Mr. Charles B. Perry, of Binghamton, N. Y., have been appointed Supervisors of Highways by H. A. Van Alstyne, New York State Engineer.

Mr. George F. Syme, formerly Resident Engineer at Delta, W. Va., for the Coal & Coke Ry., is now Resident Engineer for the South & Western Ry., with headquarters at Spruce Pine, N. C.

Mr. George R. Byrne, of the firm of Byrne & Darling, Civil Engineers, White Plains, has been appointed Chief Engineer of the Bronx Valley Sewer Commission with headquarters at White Plains, N. Y.

Mr. Leroy L. Hunter, formerly with the Engineering Department, Pennsylvania Lines west of Pittsburg, is now with the Chief Engineer, Atchison, Topeka & Santa Fe Railway, with headquarters at Chicago.

Mr. John D. Forster, of Pennsylvania, who has been engaged as Field Assistant under Mr. B. M. Hall, in New Mexico, has received a permanent appointment in the U. S. Reclamation Service as Assistant Topographer.

Mr. Orville J. Whitney has been appointed Superintendent of Water-Works of Medford, Mass., to succeed Mr. Fred. W. Gow, resigned. Mr. Whitney is a graduate of the Engineering Department of Tufts College.

Mr. Fred W. Talbot, of Orono, Me., has been appointed an Engineering Aid in the U. S. Reclamation Service and will report to Mr. F. E. Weymouth, at Glendive, Mont. Mr. Talbot is a graduate of the University of Maine.

Mr. George H. Pegram, M. Am. Soc. C. E., has been appointed Chief Engineer of the Rapid Transit Subway Construction Co., and of the Interborough Rapid Transit Co., vice Mr. S. L. F. Deyo, M. Am. Soc. C. E., resigned.

Mr Frederick P. Stearns, M. Am. Soc. C. E., Chief Engineer of the Metropolitan Water and Sewerage Board, of Boston, Mass., received the honorary degree of Master of Arts at the recent commencement of Harvard University.

Mr. Arthur M. Burtt, of Lowell, Mass., formerly Assistant Engineer and Chief Draftsman, Isthmian Canal Commission, has been appointed Supervising Architect, Isthmian Canal Commission, with headquarters at Ancon, Canal Zone.

Mr. Charles M. Butters, of Somerville, Mass., and Miss Adelaide Winchenbaugh, of Hyde Park, Mass., were married June 26, at the latter place. Mr. Butters is a Civil Engineer employed on the U. S. Government Work at Colon, Canal Zone.

Mr. F. L. Humphrey, a recent graduate of the Civil Engineering Department of Columbia University, has received an appointment as Engineer Aid in the U. S. Reclamation Service and has been assigned to duty with Mr. J. C. Camp, Snyder, Wyo.

Mr. W. A. Stadelman, Eastern Agent of The Wellman-Seaver-Morgan Co., who has been in charge of the Eastern office at 42 Broadway, New York, has been appointed General Sales Agent of the same company, with headquarters at Cleveland, O.

Mr. Paul S. Craig, of Tennessee, has been appointed Engineering Aid in the U. S. Reclamation Service and will report to Mr. J. Ahern, Cody, Wyo. Mr. Craig is a graduate of the Civil Engineering Department of the Western University of Pennsylvania.

Mr. Hiram J. Slifer has been appointed Steam Railway Expert for J. G. White & Co. He will have general supervision of matters relating to the firm's steam railway undertakings. His headquarters are at the firm's main offices, 43 Exchange Place, New York.

Mr. Thomas Fean, a Civil Engineer with the Pennsylvania R. R., and Miss Elizabeth Katherine Wiggins, daughter of Mr. and Mrs. Thomas Wiggins, of Camden, N. J., were married on June 28, in Philadelphia. Mr. and Mrs. Fean will reside at 1022 Spruce St., Philadelphia.

Mr. G. T. Barnsley, Resident Engineer of the Wabash-Pittsburg Terminal Ry., at Pittsburg, Pa., has been appointed Chief Engineer of the Wabash lines east of Toledo, O., including the Wheeling & Lake Erie, the West Side Belt and the Wabash-Pittsburg Terminal Companies.

Mr. John Findley Wallace, M. Am. Soc. C. E., resigned on June 26, as Chief Engineer of the Isthmian Canal Commission. Mr. John F. Stevens has been appointed Chief Engineer to succeed Mr. Wallace. An account of Mr. Stevens' professional career may be found elsewhere in this issue.

Mr. Friend P. Williams, of Olean, N. Y., has been appointed Resident Barge Canal Engineer for eastern half of Monroe County. Mr. George W. Keith, of Olean, is Resident Barge Canal Engineer for west section of the county. Mr. Williams will have headquarters at Fairport, N. Y.

Mr. William E. Maher, for the last three years Master Mechanic for the United Gas Improvement Company, on July 1, was appointed Acting Chief of the Highway Bureau, Philadelphia. Mr. Maher succeeds Mr. Frank E. Smith, who will resume his position as Chief Clerk of the Highway Bureau.

Mr. E. C. Woodward, of Denver, Colo., who has been temporarily employed as Field Assistant to Mr. J. E. Field in Wyoming and Nebraska, has received a permanent appointment as Engineering Aid with the U. S. Reclamation Service. Mr. Woodward is a graduate of the University of New York.

Mr. R. D. Starbuck, Division Engineer of the western division of the Michigan Central R. R., has been appointed Assistant to Chief Engineer, at Detroit, Mich. Mr. George H. Harris, Division Engineer of the Ostemo division, has been transferred to the Western division at Niles, Mich., in place of Mr. Starbuck.

Mr. John W. Hill, M. Am. Soc. C. E., and Mr. Henry Hill have opened temporary offices in the Fidelity Building, Philadelphia, in accordance with the following formal announcement: "Having for satisfactory reasons voluntarily resigned our respective positions of Chief Engineer and First Assistant Engineer, of The Bureau of Filtration, Philadelphia, we intend to resume our professional work as consulting engineers and experts for works of public water supply and other public utilities."

Col. William A. Jones, Corps of Engineers, U. S. Army, having reached the age limit, has been placed on the retired list. Col. Jones entered the U. S. Military Academy from the State of Illinois in 1860; in June, 1864, he was appointed a First Lieutenant in the Engineer Corps, and has served continuously in that organization. Since Sept. 29, 1897, he has been Division Engineer of the Chesapeake Division; member of the board of engineers, considering subjects relative to fortifications of the Chesapeake Division, and Engineer of the Fifth Light House District.

Mr. Harold U. Wallace, son of John F. Wallace, who has just resigned the Chief Engineership of the Panama Canal Commission, has accepted the third Vice-Presidency of J. G. White & Co., 43 Exchange Place, New York. Mr. H. U. Wallace resigns as Chief Engineer of the Illinois Central Railroad to accept this position. He has been connected with that road since 1894, and since 1902, has been its Chief Engineer. Among other important work carried out for the Illinois Central Railroad by Mr. Wallace was the lake front improvement work at Chicago. This work included the depression and reconstruction of 20 miles of main lines and yard tracks.

Mr. W. L. Darling, Chief Engineer of the Chicago, Rock Island & Pacific Ry., at Chicago, has been tendered an appointment to succeed John F. Stevens as Railroad Expert in the work of railway construction in the Philippine Islands. His appointment has not been announced officially, but it is understood that he will accept the place. Mr. Darling was born in Oxford, Mass., in 1856, and was educated at the Worcester Polytechnic School. He began his railroad career as an engineer with the Northern Pacific Ry. and remained with that road almost constantly until about two years ago, when he became Chief Engineer of the Chicago, Rock Island & Pacific Ry. Mr. Darling may accompany Secretary Taft to the Philippines.

Obituary.

James T. Wafer, for a number of years Superintendent of the fire alarm telegraph system of Brooklyn, N. Y., died June 28, at Phillipsport, N. Y.

T. C. Wales, Engineer of the New England Telephone & Telegraph Co., of Boston, Mass., died June 27, in that city, after an operation for appendicitis.

Austin Daniel Ewen, died on July 2, at his home in Brevoort Place, Brooklyn. He formerly was a Civil Engineer and City Surveyor. He was born in New York City in 1833, and succeeded his father, Daniel Ewen, in business. Among the estates in which he was interested were the Trinity Church Corporation and the Astor and Vanderbilt properties. He retired from business twelve years ago. He was a Civil War veteran, having served with Company D of the Seventh Regiment. His wife, son and daughter survive him.

George E. Macklin, General Manager of the Pressed Steel Car Co., at Pittsburg, Pa., died in St. Joseph's Hospital in Philadelphia, on June 26, from tuberculosis. He was born in 1863. He was graduated from the Rensselaer Polytechnic Institute, of Troy, N. Y. Mr. Macklin was at one time connected with the Colorado Fuel and Iron Co., at Salina, Kan. Later he was with the Simplex Railway Appliance Co. He became associated with the Pressed Steel Car Co. in 1899. He was also General Manager of the Pennsylvania Car Wheel Co. Mr. Macklin was a member of the Lawyers, the Central Railroad, the Ardsley and the Railroad clubs.

Rear Admiral Louis J. Allen, U. S. N., retired, died on June 29, at his home, 229 West 97th St., New York, from paralysis. He was born in Baltimore, Md., in 1840, and was educated at St. Mary's College, Emmetsburg, Md. After his graduation in 1859, he entered the United States Navy and served as Third Assistant Engineer. In 1861 he was made Second Assistant Engineer, and in 1863 he was appointed First Assistant Engineer. During the Civil War he was attached to the steam sloop Adirondack and later as Senior Engineer to the "double-ender" Conemaugh, which took part in the blockade of the forts around Charleston harbor. After the war, in 1866, he went to China. He served in various squadrons and navy yards, performing engineering duty. He was made Chief Engineer in 1871 and a Captain on March 3, 1899. In 1902 he was retired with the rank of Rear Admiral. Admiral Allen was a member of the Sons of the Revolution, the Society of the War of 1812, the Washington Light Artillery, the Grand Army of the Republic and the Union Club, of New York. He leaves a widow and two daughters.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 7 and 8. Semi-annual meeting at Chicago, Ill. Secy., W. M. Mackay, New York, N. Y.

LEAGUE OF AMERICAN MUNICIPALITIES.
August 23 to 25. Annual meeting at Toledo, O. Secy., J. McVicar, Des Moines, Ia.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
August 23 to 25, 1905. Annual convention at Erie, Pa. Secy., F. P. Foster, Corning, N. Y.

AMERICAN PUBLIC WORKS ASSOCIATION.
August 30, 31, 1905. Annual meeting at Chattanooga, Tenn. Secy., W. H. Flint, Chattanooga, Tenn.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Sept. 5 to 7. Annual meeting at Montreal, Canada. Secy., Geo. W. Tillson, Brooklyn, N. Y.

ROADMASTERS & MAINTENANCE OF WAY ASSOCIATION.
Sept. 12, 14. Annual meeting at Niagara Falls, N. Y. Secy., C. E. Jones, C., B & Q. Ry., Beardstown, Ill.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 18 to 20. Annual meetng at Bethlehem, Pa. Secy., S. S. Sadtler, 39 S. 10th St., Philadelphia, Pa.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.—The semi-annual meeting of the society will be held at the Auditorium Hotel, Chicago, Ill., on Friday and Saturday, July 7 and 8. The first session begins at 10 a. m. Friday, and the last session at 9:30 a. m., Saturday. The technical program includes the following papers: "Residence Heating by Direct and Indirect Hot Water," by E. F. Capron; "Flow of Air in Metal Pipes," by J. H. Kinealy; "Notes on the Design of Central-Station Hot-Water Heating Systems," by J. D. Hoffman; "Drying by Steam, Hot Air and Waste Gases," by H. J. Barron; "Possibilities in Heating with Hot Air," by R. S. Thompson; "Sheet Metal Radiation," by H. W. Nowell. In addition there are scheduled discussions of various questions in steam, air and water heating work.